ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LII. No. 15. New York, October 13, 1904.

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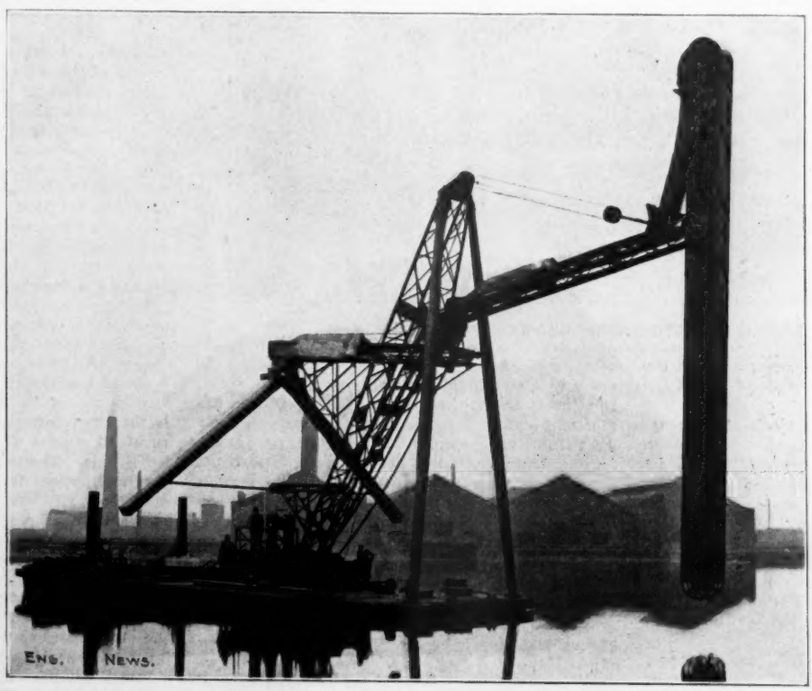
GRAIN ELEVATORS IN LONDON HARBOR.

Though little of anything has been published in the technical press concerning the handling of grain in the harbor of London, the equipment of The London Grain Elevators Co., Ltd., is only second to that of Liverpool and exceeds in importance and variety that of any other seaport.

There are sixteen elevators in the plant; three of them are pneumatic, unloading from 80 to 100 tons per hour; twelve are bucket elevators, unloading from 50 to 80 tons per hour, and one is a derrick elevator handling 150 tons per hour. The rate of discharge is remarkable. The steamship "Knight Errant," for example, discharged a load of 10,426 tons of grain in 54 working hours; the "Birchtor" unloaded 5,151 tons of grain in 34 hours; and the "Counliffe" discharged 6,094 tons in 57 hours.

Each of the elevator types noted has its peculiar application. The old bucket elevator is employed where the grain bays are large; the pneumatic elevator is used when the bays are small, and the derrick elevator is remarkable for its speed in handling the cargo. This latter type was introduced into the port of London by the Grain Elevators Co., and was invented and built by A. S. Williams, of the Atlantic Transport Steamship Co., Captain W. K. Browin and A. H. Mitchell, Chief Engineer of the same company.

This derrick elevator, illustrated by Fig. 1 and our first page picture, has a pontoon supporting a pair of shear-poles on the front, and, braced by a third leg of lattice-truss construction running back to the engine. A framed hinged boom extending from between the shears holds an adjustable, nearly vertical chain of buckets that descends into the hold of the vessel or grain barge. In use, this grain is lifted by the chain of buckets to the top of the vertical arm, where a slightly inclined chute discharges the grain upon a horizontal canvas carrier supported by the boom mentioned. The grain then falls on another carrier, bracketed out from the shear-brace, and is carried to one or both of two adjustable chutes which discharge the grain either into the hold of a ship, or into barges alongside.



VIEW OF LONDON HARBOR DERRICK ELEVATOR READY FOR OPERATION.

The steel pontoon is built square at the bow so that it can be put close to the vessel to be unloaded. It is 74.7 ft. long by 24 ft. beam, and the draft is 8 ft. At the stern there are two boilers—one in reserve; and in the hold is a small engine operating a propellor that enables the pontoon to be moved by its own power. The main engine on the deck, of 30 HP., handles the wire rope cables by which the vertical arm is raised or lowered so as to adjust it to the grain bins to be unloaded. This engine also runs the carrier gear and the chain-bucket gear, and in fact all the various movements necessary for adjustment and unloading.

When this elevator is not in use it can be made to fold back upon the pontoon in a compact manner. The deck machinery and the foot of the hinged shear-brace rest upon a carriage which runs on a double line of rails, 36 ft. long and 6.9 ft. gage. Heavy girders under the deck carry this railway; and when the apparatus is to be transported the carriage is run to the rear by appropriate drum-gear and wire-ropes, and the vertical arm is laid on the deck and the whole elevator mechanism falls within the lines of the pontoon. Everything is designed with a view to compactness, strength and ease of manipulation.

The other elevators are of well known types and need no especial description other than to say that they have been modified to adapt them to the particular needs of this port.

MOTOR CARS FOR LIGHT PASSENGER TRAFFIC ON STEAM RAILWAYS.

The motor car service for local traffic on steam railways, which has been introduced to a considerable extent in Europe, was discussed at some length in two articles in our issue of July 28, when a number of cars of this type were described and illustrated. Since then we have received further information respecting individual lines, and also a very extended report by a foreign engineer on this subject. Dealing first with the latest information, we find that three more railways in Great Britain have recently instituted this class of service, while two or three roads in this country are giving the matter some attention.

UNITED STATES.—The Lake Shore & Michigan Southern Ry. has been considering the plan of experimenting with an electric motor car having a generator driven by a gasoline engine, somewhat on the plan of the Northeastern Ry. motor car described in our issue of July 28. This would be for service on lines with light traffic. The Chicago, Burlington & Quincy Ry. is building a gasoline motor car for experimental railway work, but it is not yet in service. The gasoline car of the Tabor & Northern Ry. (9 miles) which was mentioned in our issue of July 28, resembled a large street omnibus, with entrance at one side of the front end, so that the motorman could also take tickets or fares. It was 16 ft. 6 ins. long, 6 ft. 11 ins. wide, and 10 ft. 2 ins. high from the rail to top of roof. It was mounted on four 33-in. flanged wheels, and driven by a variable-speed friction gear from a 20-HP. two-cylinder engine of the four-cycle system, having cylinders 7 × 8 ins. and running at 400 to 600 revolutions per minute. The gasoline tank had a capacity of 10 gallons. This car was built by the Chicago Motor Vehicle Co., of Harvey, Ill.

It has been suggested that the Southern Indiana Ry. (Eng. News, Feb. 25,) would be an excellent line for service of this kind, as it comprises a number of short branches with light pas-

senger traffic, presenting ideal conditions for the economical use of motor cars instead of ordinary trains.

ENGLAND.—The Midland Ry. has followed the example of other roads mentioned in our previous article, and proposes to introduce motor car service on the Hitchin & Bedford and Heysham & Morecambe branches. Two steam cars have been built at the company's shops to the designs of Mr. R. M. Deeley, Locomotive Superintendent, and Mr. Bain, Car Superintendent. The length over the body is 60 ft., and the trucks are 42 ft. c. to c., with wheels 3 ft. 7½ ins. diameter, and a wheelbase of 8 ft. At the head end is the engine room, 13 ft. long; then comes a baggage room 6 ft. 6 ins. long, with folding seats for 8 passengers. The passenger compartment is 35 ft. long, with seats for 56 passengers, and at the rear is a vestibuled platform 4 ft. 6 ins. long. The underframe is built up of steel channels, and the weight of the machine is 36 tons in working order, with 24 tons on the motor truck. The rear vestibule contains a set of levers for operating the throttle, brakes, and whistle; and also an indicator showing the engineman when to go ahead or reverse when the machine is running with the vestibule end at the head.

The steam truck or motor truck has plate frames and carries a 45-in. vertical tubular boiler, with 367 tubes 1⅛ ins. diameter and 4 ft. long. The boiler pressure is only 160 lbs. The tube heating surface is 456 sq. ft.; and total heating surface 498 sq. ft.; grate area, 11.3 sq. ft. The cylinders are outside, 11 × 15 ins. and drive the rear axle; the slide valves are on top of the cylinders and operated by the Walschaert valve gear. A tank under the car contains 500 gallons of water, and the engine-room has a bunker containing 1,350 lbs. of coal.

THE GREAT WESTERN RY., whose steam cars have already been described, has its motor cars now in service on six sections of line. Three of these are in the country districts and the other three are in suburban districts tributary to London and Plymouth. In all cases they operate as auxiliaries to the regular trains. On one of these sections of line, between Ruabon and Dolgelly, in Wales, the car makes five round trips daily, over a hilly and crooked road. The car seats 54 passengers and is sometimes filled, but the average number of passengers is 15. This average is about the same as that for the regular train, which is composed of a tank locomotive and six cars, weighing in all about 150 tons. In weight and first cost the steam car represents a saving of about 75% as compared with the train, while the operating expenses are also materially less than for the train.

The steam car of the Taff Vale Ry., designed by Mr. T. Hurry Riches (and described in our previous article), has a boiler of peculiar design. The firebox (30 × 40 ins.) is central, with a 40-in. barrel on each side, the two sets of tubes ending in chambers which are connected with a single central smokestack in front of the boiler. The dome is directly over the firebox. There are 304 brass tubes, 1¾ ins. outside diameter, and 27 3-16 ins. long.

The Barry Ry. is another of the small but busy railways in Wales; it is similar to the Taff Vale Ry. and Alexandra Docks Ry., both of which are already using steam cars. The Barry Ry. is having two steam cars built to the design of Mr. J. H. Hosgood, Locomotive Superintendent. These will be 60 ft. long, with baggage compartment and passenger compartments for 10 first-class and 40 second-class passengers. They are being built by the North British Locomotive Co.

The Bangor branch of the Belfast & County Down Ry. (Ireland), has been threatened with competition by a projected electric railway. In order to forestall this, it was proposed to convert the line to electric traction, but the cost was finally considered too great for the comparatively light traffic to be carried. In order to improve the service, however, it has been decided to institute a steam car service in addition to the regular train service, the cars making stops at road crossings and other points not served by the trains.

FIG. 1. VIEW OF DERRICK ELEVATOR ARRANGED FOR TRANSPORTATION.

REPORT ON MOTOR CARS ON EUROPEAN RAILWAYS.

A comprehensive report on this subject was presented at the convention of the International Tramways and Light Railways Union held at Vienna last month by Mr. E. A. Ziffer, President of the Bukowina Railways. From this report we have compiled the following information, supplementing the former article already referred to, and omitting experiments already described in that article. In the first place it may be noted that a report on the same subject was presented at the meeting of the German Railway Association at Trieste in 1903, and contained the following conclusions:

> It appears from the tests on the Wurtemburg Rys., the Palatinate Rys. and the Arad & Csanad Ry. that it is possible, from a technical point of view, to organize a service of motor cars, on main and secondary lines of standard or narrow gage; the cars may be operated by gasoline, steam or storage batteries, according to the local conditions and the profile of the line.

This latter report was probably the cause of the orders recently sent by the Prussian Ministry of Public Works to the different divisions of the Prussian State Railways directing them to investigate this matter, especially in regard to developing the traffic of secondary railways by a more frequent service for short distances.

STEAM CARS.

BELGIUM.—In 1887, the Belgian State Railways operated some six wheel cars having a single Belpaire boiler at one end, with the fire doors at the side of the firebox. The car body occupied the greater part of the length, and both boiler and car body were carried by a pair of deep plate frames. In 1898, this plan was developed into a car 50 ft. long over all, with two axles under the boiler, and two under the car proper, which was 30 ft. long. The boiler was set a little to one side of the center line to give room for firing. The engine has cylinders 9 × 14 ins., and the total weight of the machine in working order is 33 tons. Each steam car has an engineman, an apprentice fireman and a conductor.

The National Society of Local Railways has on one of its lines two Rowan steam cars operating between regular trains. They were originally ordered for service on a Brussels suburban line, but being of insufficient capacity they were tried on a small slow-speed line. There, however, the necessity of turning the engines at each terminal was an inconvenience, and they were finally sent to the line first mentioned to give an auxiliary service in summer. The results have not been satisfactory, and the company prefers small cars hauled by independent locomotives, so that the size of the train can be adapted to the requirements of the traffic.

GERMANY.—The Hesse State Railways in 1888 introduced a steam car designed by Mr. Thomas. At the front end was the cab, with a boiler set transversely to the steel underframe and placed directly over the driving axle. The car body was double-decked, with both floors enclosed and the upper deck reached by a rear stairway. A steel underframe extended the full length of the machine, and was mounted on three axles; the total length over buffers was 44 ft., and the total weight 30 tons. The car carried 60 passengers inside and 15 on the rear platforms. The engine cylinders were 9 × 14½ ins., and the speed was from 34 miles per hour on the level to 15 miles per hour on grades of 2%. The Saxony Railways, in 1883, bought several of the Thomas cars, but only one remains in service. They did not meet the traffic requirements, not being able to haul trail cars, and the turning of these heavy cars at the terminals was very troublesome.

The secondary railway from Gross-Lichterfelde to Teltow is operated by Rowan steam cars, which can haul other passenger or freight cars when necessary. The front end of the car is carried by a steam truck with vertical boiler, while the rear end is carried by a trailing truck. On the roof is a Rowan condenser. The cars seat 50 passengers and weight 83 tons; the steam truck weighing 8 tons. The length over all is 50 ft., and the maximum speed is 12½ miles per hour. The engine has cylinders 9¼ × 13¼ ins., and the front of the car can be opened to allow the steam truck to be run out. The cars have been in service about 15 years, with generally good results, but they are to be superseded by electric traction, in order to greatly increase the service without material increase in the cost. It is thought, however, that the steam cars could well be employed for auxiliary local service on the main lines.

The Wurtemberg Railways have in service five steam cars of the Serpollet system, but later cars have oil engines, as the boilers of the steam cars require too much care and attention. The latest steam cars (1902) are 40 ft. long over all, weighing 18 tons, and carrying 48 passengers. The cylinders are 7½ × 12 ins., and the four wheels are 3 ft. 3⅜ ins. diameter; only the front wheels are driven. The cars run from 100 to 130 miles daily. The Saxony Railways are now experimenting with a similar Serpollet steam car, using superheated steam.

The Bavarian Railways have been operating a steam car built by Ganz & Co., of Budapest, on the line between Munich and Schliersee (37 miles) since February, 1904. The boiler carries a pres-

sure of about 270 lbs., and on easy grades the machine can haul two trail cars. It carries 33 passengers. On a round trip of about 74 miles, attaining speeds of 30 miles an hour, it showed an economy of 75% in fuel consumption, as compared with ordinary trains of the same speed. The expenses for water, oil, cleaning, maintenance and wages were correspondingly low.

FRANCE.—The Purrey steam cars in use on three railways (Engineering News, July 28) have small vertical boilers, with tube coils. A header at the bottom of the boiler is connected with an upper drum by vertical tubes. From the back of the header extends the coils, which are horizontal (bent with elbows), the top of each coil entering the upper drum. The grate is directly below the tubes. The State Railways operate a double-deck car built by Turgan, Foy & Co.; this has a Turgan boiler placed directly over the driving axle, while two axles are placed under the car body. The cylinders are 11¼ × 16 ins., and the two driving wheels 32 ins. diameter. Smaller cars with four wheels (coupled), resembling a street car, but with a Turgan boiler at the front end, are operated on the narrow gage Dinard and St. Briac Ry. These have cylinders 8½ × 12 ins., and operate on grades of 5 to 6 per cent., and curves of 66 ft. radius; each steam car usually hauls a trail car.

ITALY.—The Mediterranean Ry. will operate a Purrey steam car on the line from Rome to Viterbo. The government has also permitted the Italian Automobile Co. to operate steam mail cars on the line from Vievola to Ventimiglia; there are now eight of these cars in service, each accommodating 24 passengers. The speeds are from 9 to 12 miles an hour, and the cars ascend grades of 12½ per cent.

AUSTRIA.—About 16 steam cars of the Komarek system are in use on nine different lines, of which six are of standard gage. In this system the boiler, engine and car body are mounted on a steel underframe with two axles, one of which is driven by a pair of outside cylinders. A high-pressure sectional boiler is used, with tube coils for generating and superheating the steam. The engines are compound, on the Golsdorf system. One of these cars for standard gage lines, 38 ft. long over all, and carrying 45 passengers (10 standing), weighs 23½ tons, with 14 tons on the driving axle. The cylinders are 10½ × 18 and 15¼ × 18 ins. In 1889, the Austrian State Railways experimented with a steam car of the Le Blant system on one of the Vienna suburban lines. A Serpollet steam car has also been in use since April, 1903.

As several of the steam cars were found to have insufficient power to meet all requirements of traffic, the Minister of Railways had a light tank engine built to the general designs of Mr. Karl Golsdorf; this was intended to haul one or more cars, as might be required, but ordinarily hauls a single four-wheel car with accommodation for 65 passengers. The engine is 20 ft. long over all, and has the oil fuel system, invented by Mr. Holden, Locomotive Superintendent of the Great Eastern Ry. (England), and has its firebox lined with firebrick. The cylinders are 7¼ × 15¼ and 11¼ × 15¼ ins.; and the four wheels are 31½ ins. diameter. The weight is 15 tons. The expense for wages, fuel and maintenance is only one-third of the expense for the same items on the ordinary tank locomotives used on light railways. A report made to the Minister of Railways in December, 1903, stated that from the points of view of service rendered and economy of operation, the light train of special locomotive and cars is superior to the motor car system. The subject of motor car service was discussed at a meeting of the Austrian Railway Club in January, 1904, when Mr. Karl Spitzer described the Daimler, Dion & Bouton, Ganz, Serpollet, Purrey, Turgan and Komarek systems. Figures were presented showing a material economy in cost of operation of such cars as compared with the ordinary class of equipment on secondary railways, while at the same time giving a better service.

SWITZERLAND.—A Serpollet four-wheeled steam car (using superheated steam) has been in operation for a short time on the State Railways. It is 36 ft. long, weighs 21 tons and carries 48 passengers (10 standing). It has cylinders 7½ × 12 ins., 33½-in. wheels, and makes an average of 60 to 65 miles daily. Coal briquettes are used, but it is said that the car gives more trouble than the locomotives; the boiler tubes are affected by the direct heat of the fire, and the steam pressure varies considerably, without apparent cause, causing an abnormal consumption of water and fuel. The car can be operated from either end.

HUNGARY.—About 30 steam cars on the Ganz system (already mentioned) have been put in service on some 10 different lines. They weigh from 10 to 20 tons and are carried on two, three or four axles (the last in swiveling trucks). They can be operated from either end. The two cylinders drive a shaft with two pinions (for two rates of speed) gearing with two spur wheels on a countershaft. This latter shaft also carries a heavy pinion gearing with a spur wheel on the driving axle. The engines and gearing are all enclosed. The boiler is annular, with a central cylinder for the fuel, which is automatically fed down as the ashes fall through the grate. Two annular water spaces are separated by a fire space, and connected by short inclined tubes through the latter. These cars are built by Ganz & Co., of Budapest, who are represented in the United States by Mr. G. Love, 114 Liberty St., New York. The Raab-Vesy-Primer Ry. has recently put in service a steam car on the Stolz system, weighing 17 tons and carrying 32 passengers. A high-pressure boiler is used, and the engine is compound, with cylinder 3½ × 8 and 6 × 8 ins., driving the axle by means of gearing.

The Arad & Csanad Ry. has had in service since 1898 a steam car built by the De Dion-Bouton Co. It is mounted on four-wheel trucks, with a total wheelbase of 14 ft.; and carries 17 passengers and baggage; its weight is 8½ tons. It is fitted with a two-cylinder engine, using superheated steam and geared to the axle. With six 3-ton cars attached it can run at 15 miles an hour on the level, with a consumption of 6 lbs. of charcoal per mile; when running alone it can attain a speed of 22 miles an hour on a consumption of 4 lbs. per mile. The State Railways have experimented with a Stolz car, and in September, 1903, three De Dion-Bouton cars were put in service. These latter carry 39 passengers (6 standing), and have accommodation for baggage and mails, while they can haul two trail cars. The cars are 36 ft. long, weigh 19 tons with full load (13 tons empty), and their engines have cylinders 4½ × 5½ and 7 × 5½ ins.

FIG. 2. THE PNEUMATIC ELEVATOR "CHICAGO"; WITH A CAPACITY OF 80 TONS PER HOUR.

GASOLINE CARS.

ALGERIA.—The meter gage railway from Sfax to Safsa has a small four-wheel car with two cross seats, carrying 5 passengers and a motorman. It is 10 ft. long, weighs 1½ tons, and has a 10-HP. gasoline engine running at 1,500 revolutions and driving the axles by gearing.

SWITZERLAND.—The State Railways have in service a Daimler motor car, carrying 54 passengers (8 standing). The motor is placed near the middle of the car, and has four cylinders 5¼ × 7 ins., running at 500 to 600 revolutions. The car has four wheels 41 ins. diameter, is 35 ft. long over all and weighs 17 tons loaded. It cannot haul trail cars. It runs from 60 to 65 miles daily. The vibrations due to the gearing are considerable.

STORAGE BATTERY CARS.

BELGIUM.—The Belgian State Railways are trying six cars of this kind on standard lines, for local service on main lines and branches. They carry passengers only, and seat 65 passengers, with standing room for 15 more on the platforms. Each car is mounted on a pair of trucks with a 75 KW. motor to each truck; no reduction gear is used. The current is 500 volts, 150 amperes in some cases and 350 volts, 200 amperes in others. There are 200 cells, and the capacity is 200 ampere-hours on five cars, and 350 ampere-hours on the sixth car. Westinghouse brakes and electric lights are used. The weight is 40 to 50 tons, and the cars can haul one or two cars of 8 to 10 tons weight. Stops are made at intervals of about 2 miles.

GERMANY.—The Wurtemberg Railways have a car similar to the above, equipped with two 35-HP. motors, both mounted on one truck. The batteries have 188 cells and weigh 8½ tons; they are placed under the seats. The costs of operating and maintenance are high. This car is 25 ft. long

over the sills. The Palatinate Ry. has had double-truck storage battery in service since 1895 on two lines from Ludwigshafen to Neustadt, 18 miles, and to Worms, 14 miles. These cars were adopted after an 18 months' experiment on another line. The total weight empty is 45 tons (26 for the car and accessories, 15 for the battery and 4 for the motors); with 106 passengers and two attendants the total weight is about 53 tons. The same railway has also four cars with four axles and two with three axles; all have the same equipment, but the six-wheel cars carry only 85 passengers. The cars which have been running between regular trains on one line have been taken out of service, on account of traffic conditions. The electric street railway of Munich has six storage-battery cars which haul the regular trolley cars over a section of line 1,700 ft. long, passing the royal palace, where the use of the trolley wire was forbidden. At Hanover, on the other hand, the authorities prohibited the use of storage battery cars in 1902.

The Saxony Railways, in March, 1904, organized a local service of storage battery cars between Dresden, Cossebande and Mugeln. The car now in service hauls a trail car and carries 98 passengers (80 seated), and weighs 44 tons. It can pass curves of 600 ft. radius, and when traveling alone on level track it can attain a speed of 30 miles an hour. It is operated by a motorman and conductor. It is an "articulated" car, with central platform, and each of the two sections is mounted on two axles, with 13 ft. wheelbase and wheels 3 ft. 3⅜ ins. diameter. The total length is 62 ft. The car has hand and electric brakes, and electric lights. The batteries have 184 cells, with a capacity of 430 ampere-hours for a current of 140 amperes. The car is experimental, and was built by Gottfried Hagen, of Kalk, Germany. The Bavarian Railways have a car of this type for service between Augsburg and Mering, and Augsburg and Friedburg. It weighs 26 tons, and carries 56 passengers (36 seated). The battery has 120 Tudor cells, with a capacity of 88 ampere-hours at 176 amperes intensity. Each axle has a series motor of 48 HP. The Prussian State Railways have used, since June 1903, a 26-ton storage-battery switching engine for the station at Oberhausen.

ITALY.—The Mediterranean Ry. has put a storage car in service on the line from Milan to Monza in order to develop the passenger traffic. The car is 58 ft. long, divided into four compartments and having large end platforms; it carries 90 passengers (64 seated). The normal speed is 30 miles an hour. The battery weighs 10 tons and is placed beneath the underframe; it has a capacity of 80 KW.-hours. A service with storage battery locomotives has been instituted between Bologna and San Felice (26 miles), and between Bologna and Modena (24 miles).

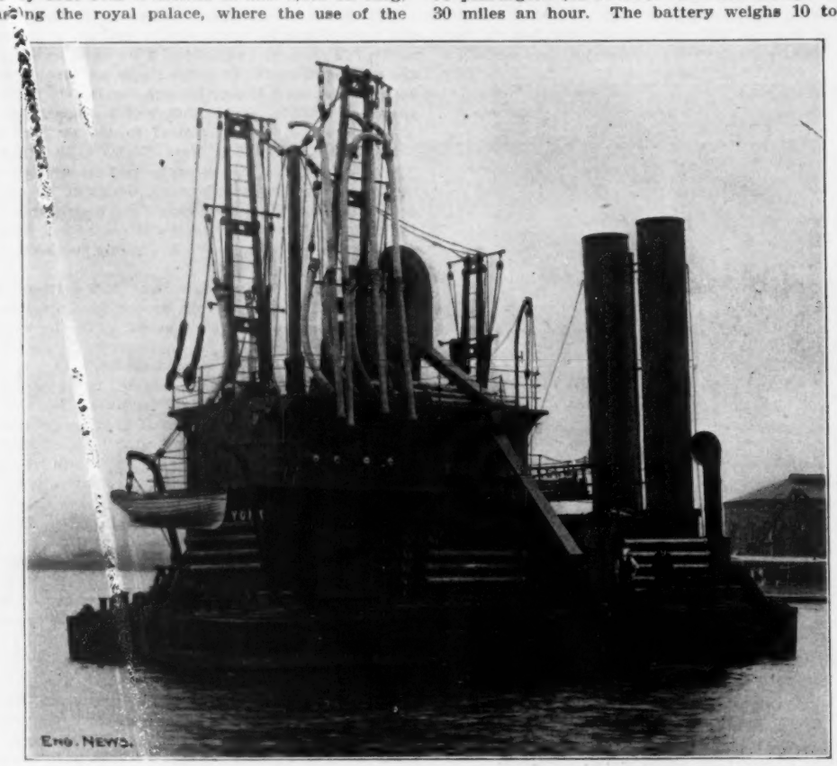


FIG. 3. THE PNEUMATIC ELEVATOR "NEW YORK"; WITH A CAPACITY OF 100 TONS PER HOUR.

CONCLUSIONS.

In presenting his conclusions, Mr. Ziffer remarks that the introduction of railway motor cars appears to be an actual necessity; for main lines they allow of an economical auxiliary service during the hours of light traffic; while for lines of minor importance they enable a more frequent service to be given and still effect an economy over ordinary methods of working. In fact it points to an entire change in the system of operating secondary railways. The selection of the motive power and the type of car must depend in each case upon the local conditions. The disadvantages of the light steam locomotive and the steam cars are the relatively low rates of acceleration and deceleration, resulting in considerable loss of time where frequent stops are made; the weight of the boiler and the vibrations due to the action of the engine are also objectionable features. These last objections, however, may be avoided by the use of a special light, independent locomotive using oil fuel. The spirit (gasoline) motor cars have a mechanism of too delicate a character for railway use, and there is a loss of power due to the gearing or other methods of speed reduction. Then again, their power is limited, they can travel only at two or three rates of speed, the smell of the exhaust is unpleasant, while there is also unpleasant noise and vibration due to the mechanism. On the other hand, the motorman can give his undivided attention to handling the machine and watching the track. Most of the railway cars of this type are as yet quite experimental, and the same is true of the few cars using alcohol. The storage battery cars have the objectionable features of great weight and limited capacity; they are not adapted to lines with heavy grades or requiring high speeds. Furthermore, they are very far from being economical. Electric traction by the trolley wire system has been applied to some local railways, but no information on this subject is now available. In general it may be said that steam traction has advantages over the other systems mentioned.

TABLE I:—Comparison of Intramural Railways.

	St. Louis, 1904.	Chicago, 1893.
Area of Exhibition	1240	660.
Length of line (double track)	6 miles	3½ miles.
Style of construction	Mainly surface	Elevated.
Conductor	Trolley	Third rail.
Service	1, 2 or 3	Trains of 3 to 5 cars.
No. of stations	17	9.
No. of cars	55 (all motor)	65 (18 motor).
Style of car	Closed, street railway	Open; compts. and side doors.
Length of car	48 ft., 2 ins.	46 ft.
Wheelbase, truck	5 " 10 "	5 ft.
Wheelbase, total	27 " 10 "	32 ft. 3½ ins.
Wheels	2 " 9 "	3 ft.
Weight	20 tons	Motor, 22 tons. Trail, 14 tons.
Passengers seated	52	84.
Motors	4 of 40 H.P. on each car	4 of 50 H.P. on motor cars.
Speed, miles per hour	10.	12.

POWER PLANT OF THE INTRAMURAL RAILWAY AT THE ST. LOUIS EXHIBITION.

The electric intramural railway is one of the features of the transportation system of the St. Louis exhibition, and it differs in many respects from the intramural railway at the Chicago exhibition of 1893. The Chicago railway was an elevated line operated with trains of cars on the third-rail system, but the St. Louis railway is mainly a surface line, with single cars operated on the trolley system, although at times two or more cars may be coupled together. A comparison of the two lines and their rolling stock equipment is given in Table I.

The power plant of the St. Louis electric intramural railway forms a section of the main power plant in the Machinery Building. It consists of seven units, comprising a Buckeye piston-valve engine, four Corliss engines, a Fleming four-valve engine, and an impact water wheel with force pump. Each unit is directly connected to a generator of the Crocker-Wheeler Co.'s make, delivering 550-volt direct current. The power plant of the Chicago railway comprised three tandem-compound and two cross-compound engines (one vertical). Four of these were directly connected to their generators, although in the main power plant most of the generators were belt connected; the 1,500 KW. generator was the largest that had been built up to that time. Table II. gives a comparison of the two power plants.

TABLE II.—Comparison of Power Plants of Intramural Railways.

	Engine, HP.	Generator, KW.
St. Louis, 1904.		
Buckeye engine	1,400	900
Lane & Bodley engine (Corliss)	900	600
Murray engine (Corliss)	800	500
Brown engine (Corliss)	750	500
Brown engine (Corliss)	750	500
Fleming engine	600	400
Water wheel and pump	160	100
Total	5,360	3,500
Chicago, 1893.		
Reynolds cross-comp. Corliss	2,000	1,500
Reynolds tandem-comp. Corliss	750	500
Hammond-Williams vert. cross-comp.	750	500
Greene tandem-comp.	750	500
McIntosh & Seymour tandem-comp.	300	200
Total	4,550	3,200

As the engines of the St. Louis power plant include a number of makes and types of engines, it will be of interest to give some particulars of their construction, but in addition to the engines themselves, there are a number of special appliances for the condenser plant, separators, etc. The Buckeye and Brown engines are connected to a Wheeler horizontal surface condenser, and the Jeanesville pumping engine has a Berryman condenser. The Lane & Bodley, Murray and Fleming engines are served by an Alberger horizontal counter-current surface condenser of spe-

cial design and with 5,000 sq. ft. of cooling surface. Contrary to ordinary practice, the steam enters at the bottom and the cooling water at the top. Thus the air which leaves the condenser at the top is cooled by the upper tubes, while the water of condensation leaving at the bottom is heated almost to the temperature of the incoming steam. The dry vacuum pump is of the horizontal type, and the circulating water is supplied by a double-suction balanced centrifugal pump directly driven by a vertical engine. All the engines take steam at 150 lbs. pressure at the throttles.

BUCKEYE ENGINE.

The largest engine of this plant is the 1,400 HP. horizontal cross-compound condensing engine built by the Buckeye Engine Co., of Salem, O. The special feature of this engine is in the steam distribution, which is effected (in each cylinder) by a main piston valve, within which rides a cut-off valve. This arrangement is shown in Fig. 1. The valves being concentric, the stem of the cut-off valve passes through the hollow stem of the main valve, and is extended beyond the end of the latter. There are two eccentrics to each cylinder; the main eccentric rod operates a vertical rocker arm with extension rod to the main valve stem, while the cut-off eccentric and valve are connected to arms on a rock shaft journaled in the rocker arm. The main valve opens the steam and exhaust ports, and closes the latter at the point of compression; the lead, release and compression are thus constant, whatever the load on the engine. The cut-off valve has no other function than to control the point of cut-off, which can be varied from within the first inch of travel of the piston to ⅝ of the stroke. This allows for an overload capacity of 40 to 50%. This valve is driven from an eccentric, which rides upon the shaft and is connected to the shaft governor. The governor acts by rotating the eccentric upon the shaft, and thus shifting the position of the cut-off valve relative to the main valve. By this arrangement of the gear, the cut-off has a constant travel

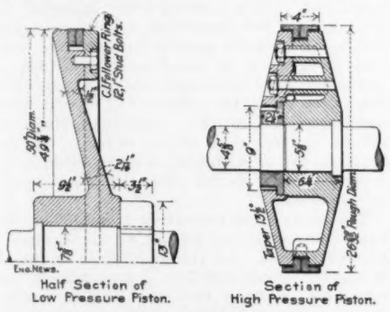


Fig. 2. Pistons of Buckeye Engine.

and travels always to the same point of the main valve. The chief advantage claimed for this valve and gear, as compared with the Corliss system, is that it does not require to be kept in such delicate adjustment. Thus a misadjustment which would be sufficient to cause a Corliss engine to do a great percentage of its work in one end of the cylinder, would, in the Buckeye engine be so unimportant that the variation from true adjustment could scarcely be detected on the indicator diagram.

The engine is of the company's heavy-duty, rolling-mill type, rated at 1,400 HP., but having a maximum capacity of 2,200 HP., running at 100 revolutions per minute. The cylinders are 26½×48 ins. and 50×48 ins. The area of the steam ports is 0.1 of the area of the cylinder, while that of the exhaust ports is ⅛ the area of the cylinder. The oil for lubricating the main bearings is fed from a small tank over each bearing, the tanks being filled by a pump worked from one of the rockers. The engine has a 10-in. steam pipe, 12-in. high-pressure exhaust, 16-in. pipe from receiver to low pressure cylinder, and 18-in. exhaust to the Wheeler surface condenser.

The cylinders, guides and main bearings are in three separate castings, and the guides are of the bored type. The high pressure piston, Fig. 2, is of box pattern, oval in section, with a body casting and follower bolted together and gripping between them two L-shaped packing rings, which project beyond the body and form the face of the piston. The low pressure piston, also shown in Fig. 2, is a single dished disk, with a pair of plain packing rings held up by a follower ring attached to the back of the piston by tap bolts. The piston rods are 4⅝ and 6½ ins. diameter, with diameters of 5½ and 7⅝ ins. for the piston fits; the pistons rest against collars. Both rods extend

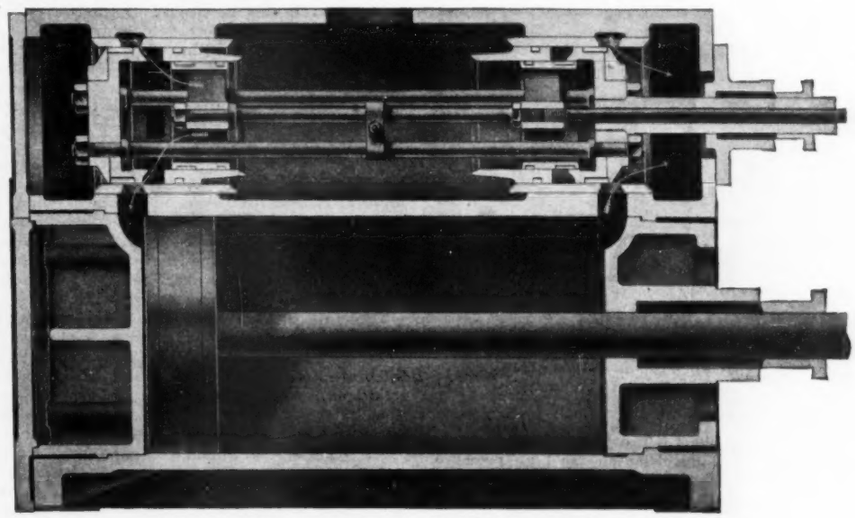


FIG. 1. MAIN AND CUT-OFF VALVE OF BUCKEYE ENGINE.
Buckeye Engine Co., Salem, O.

through the back cylinder covers and have the tail ends fitted with slipper guides. The front ends of the piston rods are screwed into heavy crosshead castings, with top and bottom shoes.

Crosshead pins are usually made with taper fits in the crosshead, but in this engine the pin is cylindrical, but with a smaller diameter for the inside fit. It is firmly gripped by the crosshead. The front of the crosshead casting is split, as shown in Fig. 3, and the gripping action on the pin is effected by a pair of heavy studs and nuts. The cost of replacing a pin made in this way is said to be about half as much as for a pin with taper fits. It has a diameter of 8 ins. for the rod

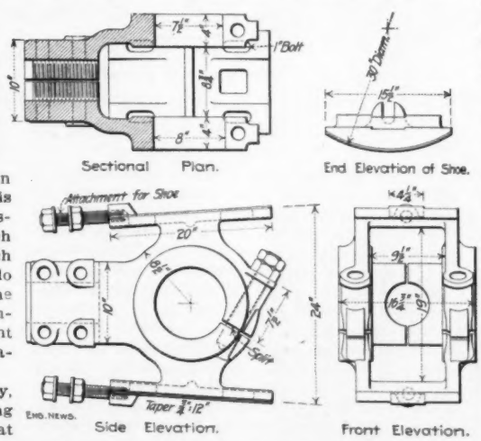


Fig. 3. Split Crosshead of Buckeye Engine.

bearing and outside fit, and 7½ ins. for the inside fit; it is bored and oil fed. The connecting rods are 11 ft. c. to c., with solid ends, and have the adjusting wedges at the inner end of each head, as shown in Fig. 4. The rods are flat, 3⅜ ins. thick, with a depth of 7¾ ins. at the crosshead end and 9 ins. at the crank end of the web. The flywheel is 15 ft. diameter, with eight arms, and is cast in two pieces. At the hub, bored to 26 ins., there are four through bolts. At each rim joint there are two hollow oval links shrunk on (instead of dumb-bell or T-head links), reinforced by a pair of U bolts with a spread of 17¾ ins. This arrangement is shown in Fig. 5. The weight of the flywheel is 40,000 lbs.

LANE & BODLEY CORLISS ENGINE.

This is a horizontal, cross-compound, condensing Corliss engine, built by the Lane & Bodley Co., of Cincinnati, O. It is rated at 900 HP., has cylinders 20×54 ins. and 40×54 ins., and runs at about 85 revolutions per minute. The steam pipe is 6 ins. diameter, and the low pressure exhaust pipe 18 ins. diameter.

Fig. 6 is a section of the high-pressure cylinder. It has a large steam chest so as to prevent wire-drawing of steam through the throttle valve, and the exhaust chamber is separated from the cylinder by an air space filled with non-condensing material. The valves are placed close to the cylinders to reduce clearance, and are of as small diameter as possible, in order to reduce friction, but the area of the steam ports is ample for a piston speed of 750 ft. per minute. Double port openings are used for both steam and exhaust, thus reducing the angular motion of the valves, and the valves seat directly over the ports by gravity. The high pressure valves are 4¾ ins. diameter, with two ports 13-16-in. wide for the admission and 1 1-16-ins. for the exhaust. The low pressure valves are 9 ins. diameter, with two ports 1 11-16 ins. wide for the admission and 2⅛ ins. for the exhaust.

The high-pressure piston, Fig. 7, is of the Babbitt & Harris patent, with a "spider," follower and an annular junk ring which forms the face of the piston and is grooved for the self-adjusting packing rings. The low pressure piston is a box casting, with a groove to receive a Babbitt & Harris packing ring. The piston rod has a straight fit in the piston, being forced in by hydraulic pressure, and riveted over. The other end is screwed into the crosshead. The piston rods are 3 11-16 ins. and 4 11-16 ins. diameter for the high and low pressure cylinders. Each cylinder is bolted to a main frame in which are formed the bored guides and the main bearings.

The crossheads are box castings, fitted with taper slippers which are faced with babbitt and turned to the radius of the guides. The crosshead pins are of open-hearth steel, with a taper

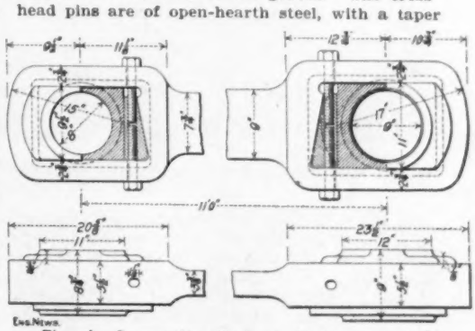


Fig. 4. Connecting Rod of Buckeye Engine.

bearing at each end. The connecting rod has slotted ends, with adjusting wedges behind the inner brasses at each end. The crosshead end has bronze boxes, and the crank end is lined with babbitt metal. The crank pins are of open-hearth steel forced by hydraulic pressure into the crank disks which are similarly forced upon the 22-in.

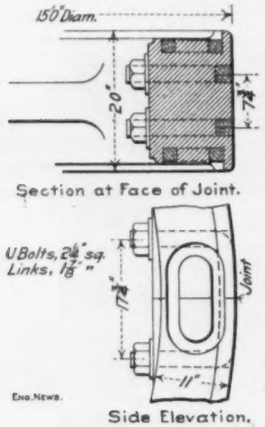


Fig. 5. Flywheel Fastenings; Buckeye Engine.

hammered steel shaft. The journals are 17 15-16 ins. diameter, 22 ins. long on the high pressure side and 30 ins. on the low pressure side. The main bearings, Fig. 8, are filled with babbitt, bored out, and are made with removable quarter boxes, bottom boxes and caps. The quarter boxes can be removed without disturbing anything but the caps, and are adjusted by wedges forced down by jack screws through the caps. To remove the lower box, the shaft is slightly raised, when the box can be rolled on the shaft and taken out. The flywheel is 18 ft. diameter, weighing 60,000 lbs., and is cast in two pieces, held together at each joint by two T-head links and a 3½-in. bolt through lugs inside the rim.

The valve gear is of the double eccentric type, with direct connection from the eccentric rods to the valves, thus eliminating the wrist plate. The eccentric rods are connected to two rocker arms on a single pin, one above and the other below the pin. The upper arm has a pin to which are attached the steam eccentric rod and parallel rod, the latter being attached directly to the crank arm of the releasing gear. The exhaust rods are connected to the lower arm and the exhaust valves in the same way, except that as no releasing gear is used the rods are attached to arms keyed upon the valve stems. The total travel of the rod is only 3½ ins., thus reducing the vibration. The light construction of the valve gear, the double-ported valves and the small dash-pots are said to enable the engine to be run at speeds unusually high for Corliss engines, though its engines run normally at 85 revolutions.

The arm or lever of the steam valve is keyed

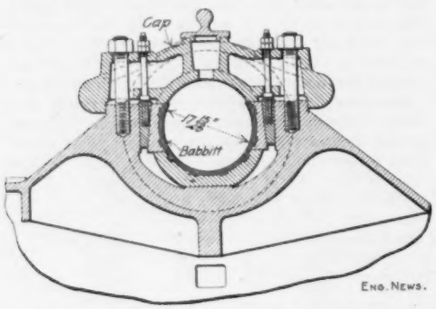


Fig. 8. Main Bearing of Lane & Bodley Corliss Engine.

upon the valve stem and secured by a clamp bolt. It is placed between the front bearing and the stuffing box in the bonnet, the stem being thus supported on both sides of the arm, avoiding overhang. The dash-pot connection is placed in the center of this lever. The releasing hooks and levers are fitted with reversible hardened steel catch plates, and the hooks are operated by gravity without the aid of springs. The cam collars which are controlled by the governor are of small diameter, thus reducing the load on the governor. The dash-pots, bolted to the sides of the cylinders, are of an improved single chamber pattern, without compression chamber, and with the weight of moving parts reduced to a minimum. It is claimed that they put very little strain on the valve gear to ensure closure of the valves, and that they will close positively on either long or short cut-off. The latch on the dashpot rod takes hold of the steam lever direct instead of taking hold of a pin in the side of the lever. The rods are attached to the plungers by ball joints, thus allowing the plungers to rotate and so equalize the wear.

The governor is of the high-speed type with small balls, and runs at about 190 revolutions per minute; it is driven by a belt from a pulley on the main shaft. The engine is also fitted with a small auxiliary, high-speed spring-loaded emergency governor, which admits steam to a small cylinder and thus trips the emergency throttle valve, which is a butterfly valve.

The main throttle valve is of the straight-way type, with a semi-circular passage and a valve whose face is a counterpart of the valve seat. The faces are not subject to the cutting action of the steam and will remain steam tight for a long time, as the faces are flat and they can be readily refitted by scraping or grinding. The valve is operated by a bevel pinion and semi-circular gear, and requires only half a revolution of the hand wheel for full opening or closing. Beneath the valve seat is the butterfly valve which is controlled by the emergency governor above mentioned or can be operated by hand.

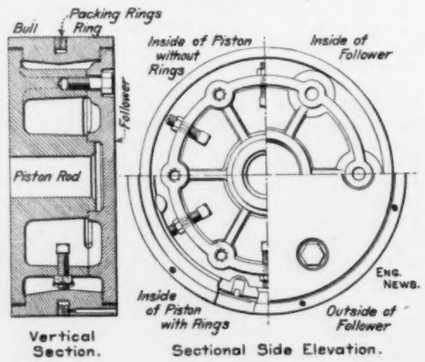


Fig. 7. High-Pressure Piston of Lane & Bodley Corliss Engine.

MURRAY CORLISS ENGINE.

This is the only large simple engine in the entire plant, and is a good example of Corliss engines of moderate size. It is rated at 800 HP., has a cylinder 26 × 48 ins., and is run at 100 revolutions per minute to meet the requirements of the generator builders, although it was not originally designed for this speed. It was built by the Murray Iron Works Co., of Burlington, Ia.

The cylinder is cast in one piece with its valve chambers, steam passages and bed plate. An 8-in. steam pipe enters the steam chamber at the top and at the bottom the exhaust chamber is connected to a 10-in. exhaust pipe leading to the condenser. The steam chamber is next to the cylinder wall, but the exhaust chamber is separated from the cylinder by an air space, so as to avoid any cooling effect due to the low temperature of the exhaust steam. The frame or bed which contains the guides and main bearing is a single casting 20 × 6 ft. having a heavy box-girder web, 44 ins. deep. The piston is of special design for this engine, and consists of a main body or spider and a follower each 14 ins. diameter, and a bull ring 26 ins. diameter with a width of 8 ins. on the face. The arrangement is similar to that shown in Fig. 7. The follower ring is 4½ ins. wide, fastened to the spider by eight 1-in. tap bolts. The bull ring is grooved for a packing ring 1-in. wide and ¾-in. thick, cut into eight pieces and set up by eight coiled steel springs in recesses behind the ring; each spring is designed to give about 30 lbs. pressure at ¼ compression. The piston rod is of mild steel, 7 2 ins. long, 4½ ins. diameter, turned down t ins. at the front end, where it is threaded for crosshead fit. The piston is pressed into the by hydraulic power, and after the follower n screwed up the end of the rod is slightly u

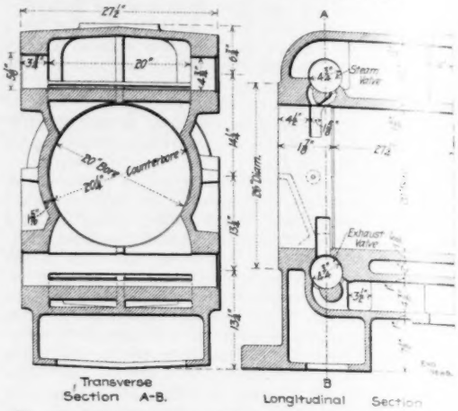


Fig. 6. High-Pressure Cylinder of Corliss Engine. Lane & Bodley Co., Cincinnati, O.

The cross-head is of cast iron with 10% of wrought steel scrap, and is made with a heavy neck into which the piston rod is screwed. The cheeks are connected by the top and bottom shoes, faced with babbitt and turned to 30 ins. radius to fit the bored guides. The bearing faces of the main body and the shoes have a taper of 1 in., and screws at the rear of the crosshead allow of adjusting the shoes to take up wear. The steel crosshead pin is fitted by grinding, and is secured by a forged steel nut. This pin is 17 ins. long, with taper fits in the cheeks of the crosshead, and with a bearing 7 ins. diameter and 8 ins. long for the connecting rod. The crosshead and crank pins are each drilled with an axial oil hole and two ¼-in. holes to the surface. The hammered steel connecting rod is of circular section, with solid ends slotted out for the brasses, which are set up by adjusting bolts, with wedges the full width of the brasses. One set of brasses has the wedge on the inner side, and the other set has it on the outer side, so as to equalize the wear.

The shaft is of hammered iron, 15 ins. diameter at the ends and 20 ins. at the flywheel and generator seats. On the 12-in. head of the shaft is keyed a crank disk 5 ft. 2 ins. diameter and 7 ins. thick, made of the same iron as the crosshead, and in this is the steel crank pin with a bearing 8 × 8 ins. for the connecting rod. The bearing next to the crank disk is 15 × 34 ins., and next to this are the governor pulley and the two eccentrics. The outboard bearing is 15 × 30 ins., and is supported by a special pedestal. The lower brass of each main bearing is adjusted by means

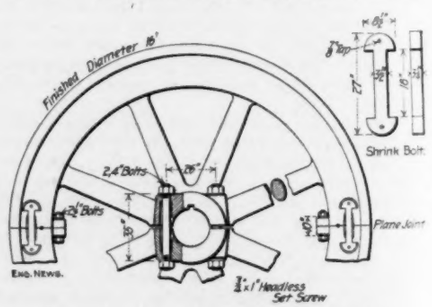


Fig. 9. Flywheel of Murray Corliss Engine. Murray Iron Works Co., Burlington, Ia.

of a wedge shoe on which the brass rests, and which can be adjusted to position by a 2-in. bolt. The flywheel, Fig. 9, is 16 ft. diameter and weighs about 70,000 lbs. It is made in two sections, put together with four shrink-bolts of tee-head links, each drawn from a solid piece of mild steel. In addition to this, there are lugs on the inner side

of the rim to receive a 2½-in. stud bolt at each joint, while four 4-in. stud bolts are put through the hub.

Double-port valves are used, 7 ins. diameter, and 33 ins. long, and the steam and exhaust valves are operated by separate eccentrics, 28½ ins. diameter with a throw of 8⅝ ins. Each eccentric rod operates a vertical lever pivoted to the side of the bed, from which a hook rod extends to a rocker or wrist plate carrying the valve rods connected to arms on the valve stems, as shown in Fig. 10. The area of port opening is about 50 sq. ins. for each steam valve and about 80 sq. ins. for each exhaust valve. The exhaust valves are connected directly to the rods from the rocker, but the steam valves are operated through the medium of a releasing gear.

The releasing gear is of the same general type in all Corliss engines, but the details of the mechanism vary with each builder. The arrangement employed on the Murray engine is shown in Fig. 11. The valve rod from the rocker is attached to one end of a double arm, A, which rides on the valve stem. To the other end of the arm is pivoted a U-shaped arm B, the vertical leg of which has a hook to engage with a block or projection on the inner face of the steam lever C, this lever being keyed upon the valve stem and carrying the dashpot rod, D. As the piston commences its stroke, the arm A is pulled over so as to raise the hook, which in turn raises the arm C and thus oscillates the valve. When the stroke has reached the point of cut-off the hook strikes a cam on the "knock-off" lever, E, this lever also riding on the valve stem and being controlled as to position by the governor rod. The cam releases the hook from the valve lever C, and the valve is instantly returned to the closed position by the plunger of the dashpot rod.

The catch plates of the hook and block are of hardened steel, and the latter is faced with rawhide to deaden the sound. The release end of the hook has a steel roller which rides on a rawhide face in the circular part of the knock-off lever, while the cam of this lever is a fiber block, which appears on the cut, just above the steam lever. This is a special design on account of the high speed; in the ordinary make of Murray engine no roller is used but the cam simply strikes the leg of the hook. The dash pots are of the vacuum type and are carried by brackets bolted to the cylinder casting. There are two chambers, 8 and 4½ ins. diameter, with depths of 5⅛ ins. and 6 ins. The plunger fits both chambers, and has a ball and socket connection for the rod which is attached to the steam arm of the valve gear. An air pipe is tapped into a small air chamber, and the compression screw is tapped into the wall of this chamber, which has ports opening into the bottom and side of the larger dashpot chamber. In the bottom of the dashpot is a ¼-in. relief opening closed by a 3-16-in. steel ball held in place by a steel spring.

The engine is fitted with two high-speed governors driven by Morse chain belts from a 27-in. sprocket wheel on the engine shaft. They are of the flyball type, with weighted heads, and run at about 250 revolutions per minute. The general arrangement is shown in Fig. 12. The larger governor is for the purpose of regulating the service speed, which is, of course, specially important in engines directly connected to electric generators. This is effected by a rod attached to the "knock-off" lever (E, Fig. 10) of each valve gear, so as to shift the position of the cam and so change the point of release and cut-off. The other governor operates a Murray automatic stop, shutting off steam in case the engine starts to race, or if the governor belt breaks. Above the throttle valve is a stop valve of the Corliss type, similar to the steam valves except that it is shorter and wider. The port is 3 ins. wide and 17 ins. long, and the valve is 8 ins. diameter on the face. The valve arm is attached to the rod by the same type of release gear as is used on the steam valves, the governor rod being attached to the knock-off lever. The valve is closed (when released) by a weight instead of a dashpot. An oil pump with 1½-in. plunger and 2 ins. stroke is worked by a small arm on the sleeve of the rocking lever of the eccentric rods.

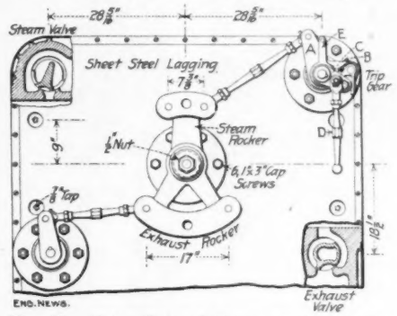


Fig. 10. Valve Gear of Murray Corliss Engine.

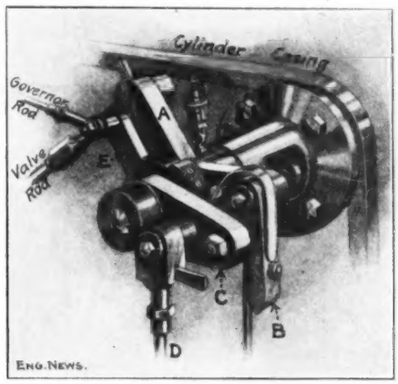


Fig. 11. Releasing Gear of Murray Corliss Engine.

THE BROWN CORLISS ENGINES.

The only vertical engines of the electric railway power plant are the 750-HP. engines (Fig. 13) built by the Brown Corliss Engine Co., of Corliss, Wis. They are cross-compound engines with cylinders 18 × 36 ins. and 36 × 36 ins. taking steam at 150 lbs. pressure at the throttle and running at the high-speed (for Corliss engines) of 135 revolutions per minute. A horizontal receiver connects the two cylinders. As shown by the cross-section of the high pressure cylinder, in Fig. 14, the cylinders are double-ported, so as to give quick opening for the steam, while reducing the throw and momentum of all parts of the valve gear. The engines work very noiselessly at this high speed, and in fact with the above arrangement reducing the angular movement of the valve gear, aided by an improved form of steam dashpot now being introduced, a speed of 150 revolutions per minute may be successfully maintained.

The special feature of this engine, as in all Corliss engines, is the arrangement of the valve gear, and this is very clearly shown in Fig. 15. Separate eccentrics are used for the steam and exhaust valves, and each eccentric rod operates a rocking lever. From the steam lever, the hook rod runs directly to the arm on the valve stem, and the arms of the upper and lower steam valves are connected by a rod so as to work simultaneously. The wrist plate is thus eliminated, and by this arrangement there is obtained a long range of cut-off, varying from 0 to ⅞-in. stroke. For the exhaust, the hook rod leads to a wrist plate with rod connections to the two valves. The releasing gear is shown in Fig. 16. The valve rod in moving to the left revolves the arm around the valve stem, and with it the hook which engages with the drop lever keyed upon the valve stem. At the point of cut-off the knock-off lever is thrown back by the cam and disengages the hook from the drop lever, when the dashpot rod pulls down this lever and thus turns the valve to the closed position. The point of cut-off is varied by the governor rod, which shifts the position of the knock-off cam. The drop lever, to which the dashpot rod is attached, is placed within the bonnet, so as to reduce to a minimum the strain upon the valve stem. The dashpots used on this engine are of the ordinary vacuum type, and are attached to the cylinder and guide castings. The steam and exhaust pipes of the high-pressure cylinder are 6 and 7 ins. diameter; those of the low-pressure cylinder are 12 and 14 ins. diameter.

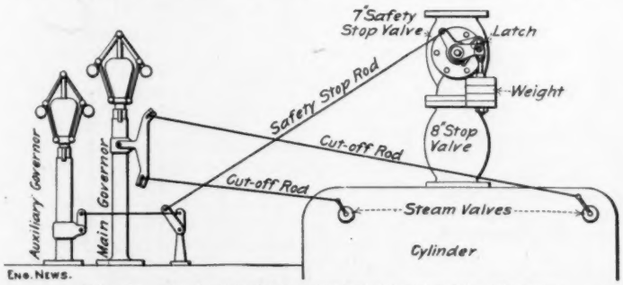


FIG. 12. GOVERNORS OF MURRAY CORLISS ENGINE.

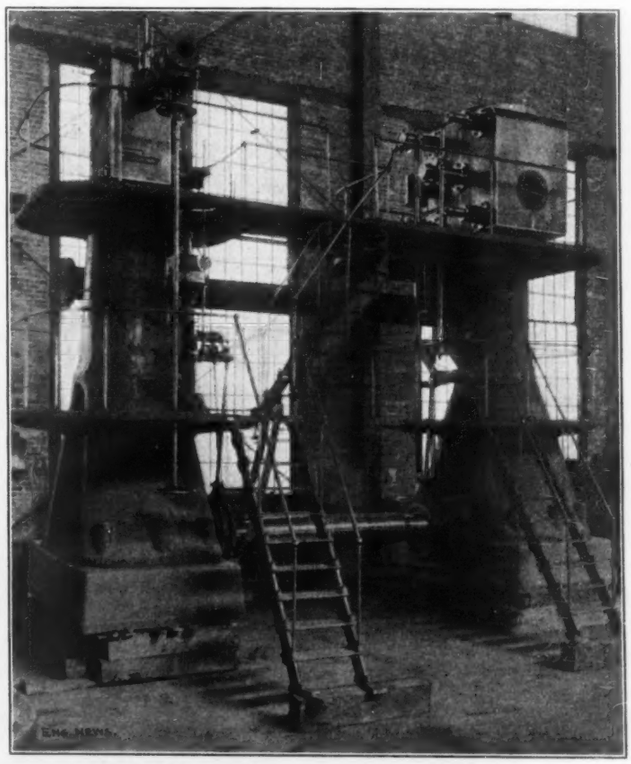


FIG. 13. TWO BROWN VERTICAL CORLISS ENGINES.
Brown Corliss Engine Co., Corliss, Wis.

The governor, Fig. 17, is of the high-speed weighted type, provided with an automatic gravity safety stop. The weight is heavy and as the governor is run at about 300 revolutions per minute, it is very sensitive, varying the cut-off with slight changes of load. The safety stop rod is attached at the upper end to an arm which is connected to the cut-off lever by a latch. Its lower end is attached to an arm on a shaft which has another arm carrying a roller riding on the governor belt. Should the governor belt break, disconnecting the engine from the governor, this arm would drop, raising the other arm so as to release the latch, when the weight on the end of the cut-off lever would turn it sufficiently to shut off the steam.

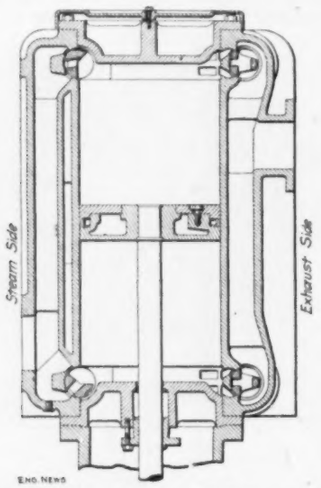


Fig. 14. Section Through Cylinder and Valves of Brown Corliss Engine.

The crossheads are of box pattern, with babbitted shoes made adjustable by wedge and screw and turned to fit the bored guides. The crosshead pins are of open-hearth steel, with taper fits, flattened slightly on the top and bottom. The connecting rods are of circular section, with solid ends slotted out square, the boxes being adjusted by wedges moving laterally across the face of the box instead of moving lengthwise along the face. With the square slot and lateral wedge the box has always a bearing for its full length upon this wedge, as shown in Fig. 18. The construction is such that taking up the wear does not affect the distance between centers of pins.

The shaft is 17 ins. diameter at the wheel and generator seats and has main bearings 13 × 24 ins. The flywheel is 14 ft. diameter, and weighs 36,000 lbs. It is built up in two sections, put together with T-head links in the rim and through bolts at the hub.

THE FLEMING ENGINE.

This engine presents some notable features in engine design, more particularly in regard to valve gear. It is a horizontal tandem-compound engine, with unusual cylinder proportions, and four valves to each cylinder. The valves are of the Corliss type, but are controlled directly, without any trip or releasing gear, the arrangement being such as to give a sharp cut-off. The special advantage claimed for the engine is that it runs at considerably higher speed than the ordinary Corliss engine, without the use of any elaborate trip gear and dashpot construction, and yet gives a higher economy than the latter engines. On the other hand, while the trip gear and dashpot are eliminated, the engine requires three eccentrics and an increased number of parts in the valve gear. The regulation by an automatic inertia governor on the shaft, instead of by a flyball governor as used on Corliss engines, is also claimed as an advantage over the latter. The engine was built by the Harrisburg Foundry & Machine Works, of Harrisburg, Pa., and the construction and tests of the first engine of this type were described in our issues of Dec. 3 and 10, 1903.

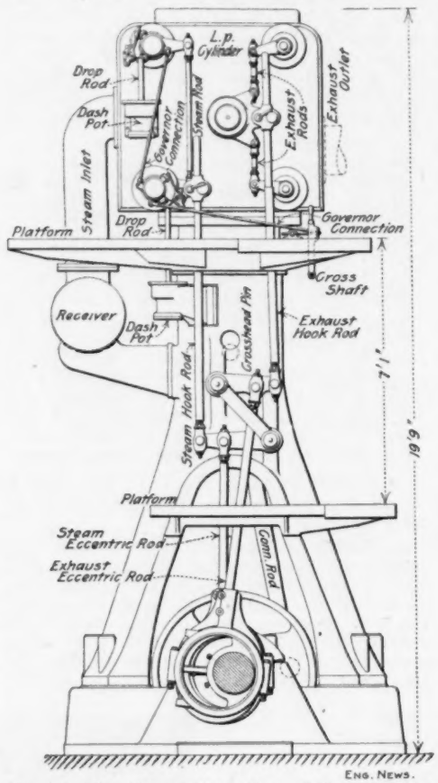


Fig. 15. Elevation of Valve Gear of Brown Corliss Engine.

The cylinders are 15 × 26 and 40½ × 26 ins., the stroke being short and the proportions giving the unusual cylinder ratio of 1 to 7.3. The flywheel is 10 ft. diameter, with a weight of 22,500 lbs., and the normal speed of the engine is 150 revolutions per minute, with a variation of 1½% under extreme changes of load. The cut-off is about 0.3 in the high pressure cylinder. Between the cylinders is a receiver of the reheating type, having horizontal tubes, and to this the steam is admitted at 150 lbs., which is the full pressure at the throttle. The high pressure steam admission is 8 ins. diameter, and the low pressure exhaust 14 ins. diameter. The high-pressure cylinder has 4⅜-in. steam valves and 5-in. exhaust valves, the former being triple ported and working in bushings of chilled cast iron, the low pressure cylinder has 8-in. steam and exhaust valves. The low-pressure steam valves and all the exhaust valves are double ported.

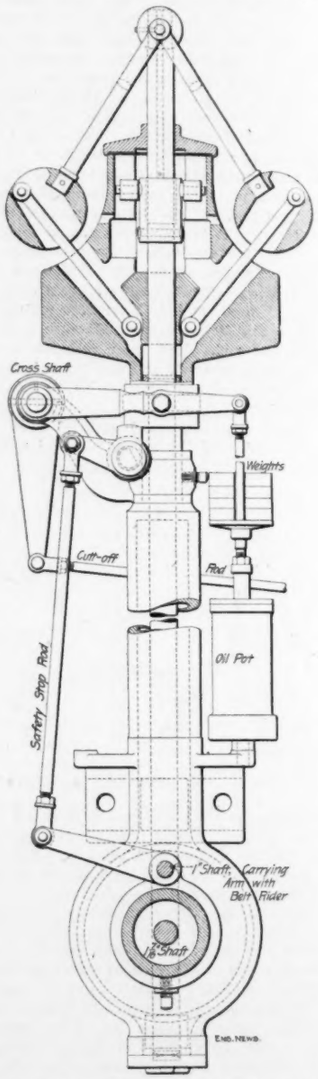


Fig. 17. Governor of Brown Corliss Engine.

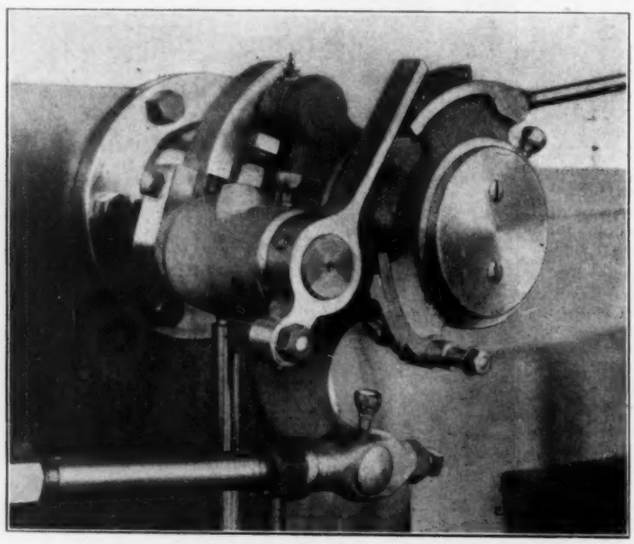


FIG. 16. RELEASING GEAR OF BROWN CORLISS ENGINE.

The valve gear is operated from three eccentrics: Two of these are keyed upon the shaft and the third rides loose, its position upon the shaft

being shifted by the shaft governor. This loose eccentric operates the steam valves of the high-pressure cylinder. One of the fixed eccentrics operates the steam valves of the low-pressure cylinder (which have a fixed cut-off), and the second fixed eccentric operates the exhaust valves of both cylinders. The valves are connected up through the medium of vertical rocking levers

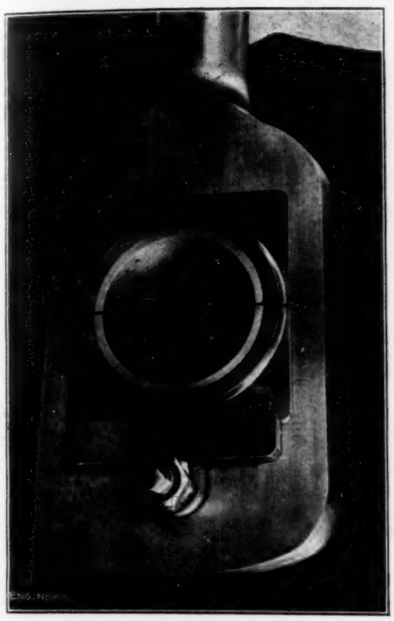


Fig. 18. Crank-Pin End of Connecting Rod, Brown Corliss Engine.

and extension rods, with bell crank connections to the valve stems. It is the arrangement of these bell crank connections which give the quick cut-off without the use of trip gear and dashpots, and Fig. 19 shows the connections to the rear steam valve. The extension rod from the rocker is attached to the lower arm of the bell crank lever A, the upper arm of which is connected by a link B, with the arm C keyed upon the valve stem. In the high-pressure steam valves the lead is decreased at the earliest point of cut-off, and it is claimed by the builders that this is largely responsible for the remarkable uniformity in steam consumption under varying loads. In a recent test the variation in steam consumption per HP. per hour between a load approximating one-sixth of the rated power of the engine and the full rated load was only 2.09 lbs.; steam consumption at most economical point being 12.33 lbs., and only 14.42 lbs. at one-sixth load.

IMPACT WATER WHEEL AND PUMP.

The water power unit of the plant is of interest not only on account of the water wheel itself, but also on account of the pumping engine which supplies the power. The 100 KW. generator is mounted on the shaft of an impact water wheel 31 ins. diameter and running at a speed of 700 revolutions per minute; a Lombard governor is used, operating a needle nozzle, which controls the 1¼-in. water jet. A triple-expansion horizontal, direct-acting duplex pump, Fig. 20, delivers 1,200 gallons of water per minute at a pressure of 300 lbs. per sq. in. No receiver is used, the steam exhausting directly from one cylinder into the next and thence passing to the condenser. The two high-pressure cylinders, taking steam at 150 lbs.) are 11 ins. diameter; intermediates, 17 ins. low-pressure cylinders, 30 ins.; plungers, 10 ins.; the stroke is 36 ins. Each steam cylinder has two semi-rotating valves, operated from the plunger crosshead; and the high-pressure valves are fitted with an adjustable cut-off. The water end has double-acting outside-packed plungers, and 16 valve chambers. Each chamber has four bronze wing valves with bronze seats; the stems of the valve guards extend through the covers of the valve chambers and are fitted with outside loch nuts, by which the lift of the valves can be regulated. The pump is fitted with a Fisher governor, and has its condenser placed in the suction pipe. The water wheel was built by the Abner Doble Co., of San Francisco, Cal., and the pumping engine by the Jeanesville Iron Works Co., of Jeanesville, Pa.

THE HARLEM RIVER TUNNEL SECTION OF THE NEW YORK RAPID TRANSIT RAILWAY.

In our issues of Oct. 1 and 8, 1903, we described the novel construction of the New York Rapid Transit tunnel under the Harlem River, as completed to that date; and for the details of that construction our readers are referred to these illustrated articles. Guided by the experience gained in building the western section, Mr. D. D. McBean, one of the contractors for this work, radically changed the plans for the building of the eastern half of the tunnel, with the approval of the Chief Engineer of the Rapid Transit Railway; and this later plan is here described.

That the new method may be better understood, some general description of the site and the manner of building the first half of the tunnel is necessary. The section of the Rapid Transit Railway constructed by the firm of McMullin & McBean, of New York City, crosses the Harlem River on a nearly east and west line, and extends from a point on Lenox Avenue, 100 ft. north of 135th Street, to the center of Girard Avenue, in the Borough of the Bronx. The approach tunnels on either side of the river have a descending grade of 3%. These land sections were built in open cut, and beyond the unusual depth of excavation they presented no exceptional engineering features. In them the type of construction was the standard double-track concrete and steel beam subway, with a single arch of 25 ft. span used for a short length adjacent to each end of the twin-tube section employed directly under the river. The river section was 610 ft. long, or 400 ft. between pier-head lines. The base of the rail was to be located about 48 ft. below mean high water, and this line was laid down on a vertical curve of 7,517 ft. radius. The river-tunnel plans called for a cross-section showing two cast-iron cylinders, each 15 ft. inside diameter, so joined at the middle by a cast-iron diaphragm that the centers of the cylinders were 12 ft. 6 ins. apart horizontally. The middle diaphragm was 16 ins. wide, and was pierced by a double vertical series of 3-in. ducts for wires. The track base in each cylinder was concrete; and the pair of cylinders was finally embedded in

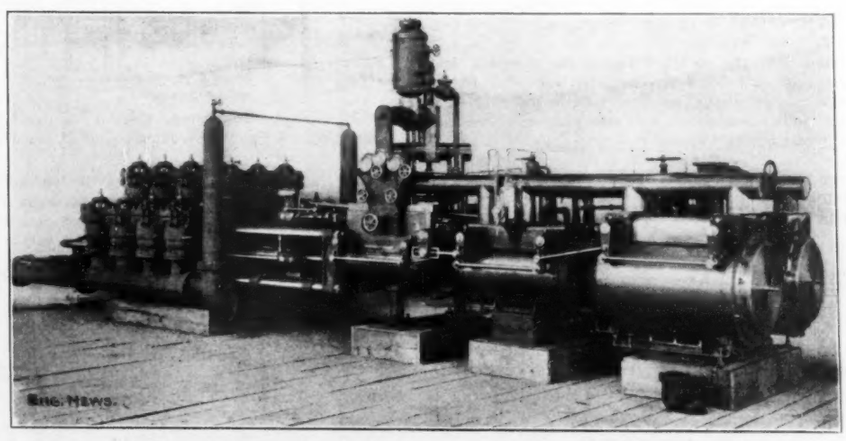


FIG. 20. TRIPLE ENPANSION PUMPING ENGINE FURNISHING JET FOR IMPACT WATER WHEEL. Jeanesville Iron Works Co., Jeanesville, Pa.

a rectangle of concrete with the upper corners cut off.

The material forming the river-bed had much to do with the plans of tunnel construction adopted. This material was sand, gravel, clay, and an exceedingly fine silt that when wet would flow like a fluid. The sand, too, was practically a quicksand. This unstable material, and especially the fact that there was no cover over the tunnel at the deepest part of the channel, made tunneling by the shield method impracticable. The depth of water in the river was 26 ft., with a tidal range of about 5 ft.

To meet these difficult and unusual conditions, Mr. D. D. McBean devised and carried out the plan described in our issue of Oct. 8, 1903. Briefly stated, the method adopted for building this western portion of the tunnel was as follows:—The site of the tunnel was first dredged down to a depth that would leave 6 to 8 ft. of material to be removed after the chamber to be described had been formed. Then, very substantial pile, service platforms, 20 ft. wide, were built parallel to each side of the proposed tunnel, and, as will be seen later, these platforms had important functions to perform. Next, four longitudinal rows of piles were driven in the site of the tunnel, each row being 6 ft. 4 ins. apart transversely, and 8 ft. apart lengthwise. These piles were cut off under water at a point about 11 ft. above the center line of the iron tunnel cylinders, and they

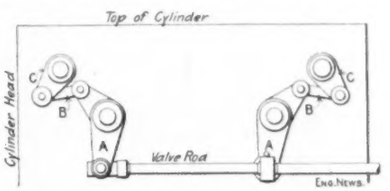


Fig. 19. Steam Valve Gear of Fleming Engine. Harrisburg Foundry & Machine Works, Harrisburg, Pa.

were then capped transversely with 12 × 12 in. timbers. These piles were intended to carry a heavy inside bracing-frame for the sheet piling when driven; to carry a lower guide-frame to be used in driving the sheeting; and they were finally to be cut off at sub-grade and then served as further support for the finished structure. The bracing and guide-frame was built in sections about 216 ft. long, was floated to place, accurately lined and then sunk and bolted to the 12 x 12 in. caps mentioned. It may be here said that this bolting under water was usually performed by a diver placing the bolt and setting over it a guide-pipe; the driving was then done by a rod struck by men on the surface.

With this preparation, a line of 12 x 12 in. tongue-and-grooved sheet piling was very carefully driven to refusal with a 6,000-lb. hammer, on each side of the tunnel site, and 31½ ft. apart C. to C. Then, by a circular saw working from the service platforms, these two lines of sheeting were very accurately cut off on a line just above the roof of the proposed twin-tunnel, and conforming to the tunnel grade. Cross-bulkheads of 12 x 12 in. sheeting completed the sides of the box thus made. The next operation was to build and float out a roof for the box. This roof was 40 ins. thick in all, and was composed of three layers of 12 x 12 in. timbers, laid at right angle to the axis of the tunnel, with the layers sepa-

rated by two courses of 2 in. plank laid longitudinally. This roof was well caulked, and made perfectly water-tight. On the under edges of this roof and parallel to the tunnel were bolted two 12 x 14 in. rangers, which were spaced to set exactly over the lines of sheet-piling; and on the roof had no function to perform after the tunnel was completed, and a section of it actually had to be removed later to provide the requisite depth of channel. This new plan was carried out as follows:

As before, the site was dredged to nearly sub-

structed, 106 ft. long, 35 ft. wide and 12 ft. deep. The bottom was made of 12 x 12 in. transverse timbers laid 4 ft. apart, and floored with 3 x ... in. planks; the vertical side sticks were 4 x ... ins., and to these were spiked 3 in. planks. ... joints in the bottom and sides were well caulk...

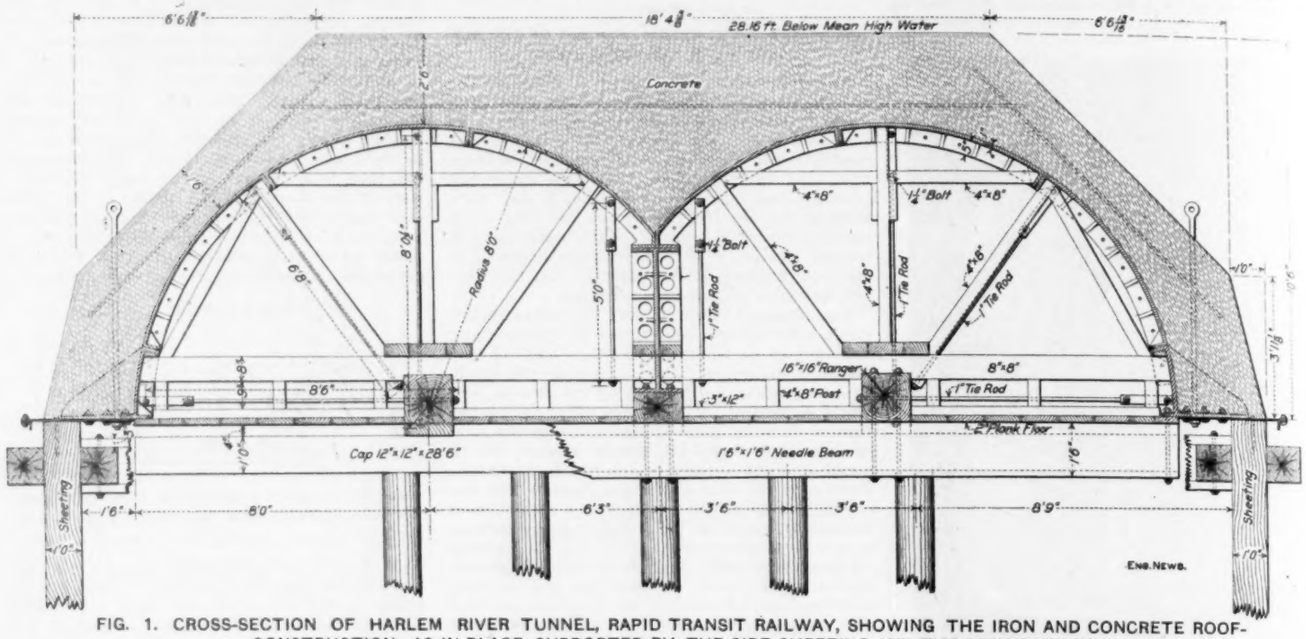


FIG. 1. CROSS-SECTION OF HARLEM RIVER TUNNEL, RAPID TRANSIT RAILWAY, SHOWING THE IRON AND CONCRETE ROOF-CONSTRUCTION, AS IN PLACE, SUPPORTED BY THE SIDE-SHEETING AND THE CENTER PILES.
McMullen & McBean, Contractors.

center-line of the rangers was bolted a T-iron, which was intended to assist in making a joint between the sheeting and the roof by cutting into the sheeting. This precaution was later found to be unnecessary, as the mud soon filled any slight crevice at this point. As the chamber to be formed was about 216 ft. long, the roof was built in two sections, and in the centre of each was a rectangular tight shaft, 7 × 17 ft., extending above the water line, and later fitted with air-locks of the usual type, and with a rotary and a direct-acting pump.

When the roof was floated to the tunnel site, it was carefully aligned, sunk in place, and then weighted with about 5 ft. of dredged material. The box thus completed was now pumped out, and, upon entering through the shafts, it was found that the joints between the sheeting and the roof and between the sheeting-piles themselves were very close, and a little wedging at a few points made the box water-tight. The soft material in the bottom was now pumped out, and the heavier stuff was raised through the shafts; and with the bottom concreted, the cast-iron lining was assembled and bolted together, and then concreted in conformity with the plans.

grade, and the double line of 12 x 12 ins. sheeting was driven for the sides and ends of the submarine box, with inside bearing piles and guide and bracing frames as in the western half. But

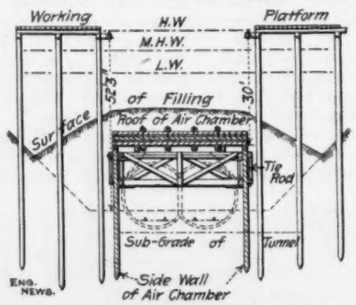


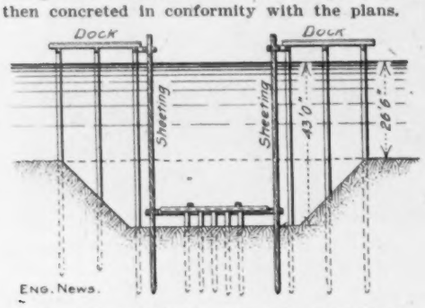
Fig. 2. Sketch, Illustrating Method Adopted in Building the First, or Western, Half of the Tunnel.

the sheeting was now cut off at the springing line of the proposed tunnel, instead of on a line considerably above the top of the iron-concrete

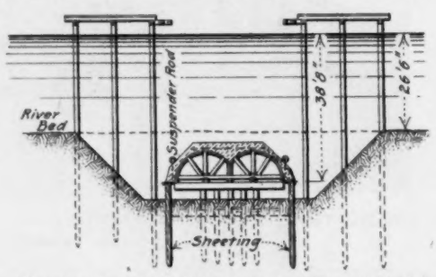
On three 4 x 12 in. longitudinals fastened to the floor of this box was then built a false floor for the upper half of the tunnel. This floor was made of 16 x 16 in. transverse timbers, 8 ft. apart, and on these were placed a center longitudinal of 10 x 16 in. timber, and two 16 x 16 in. timbers laid 6 ft. 3 ins. each side of the box-center. The space between these longitudinals was floored with 2 in. plank, spiked to the 16 x 16-in. transverse sticks and well caulked. Bolts held this flooring firmly bound together.

Upon this false floor the cast-iron tunnel lining was erected in 6 ft. rings; and, as shown in the illustration, rods and braces were introduced as precautions against any possible deformation, and suspension bars were built in for use in sinking this roof. The skewbacks are especially heavy, have a wide horizontal flange, with an outside vertical guide-flange. It might be mentioned here that this flange was drift-bolted to the top of the sheeting after the roof was sunk. This was done by leaving openings in the concrete covering this flange; and the bolts were then set by a diver and driven as described before.

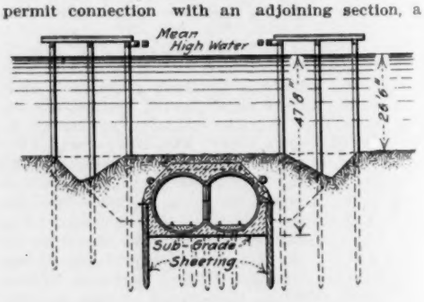
To close the ends of this roof-box, and yet to permit connection with an adjoining section, a



(Tunnel Trench, Docks, and Submerged Frame Resting on Pile Caps.)



(Sheeting Cut-off and Upper Part of Tunnel Shell in Position, Forming the Roof and Sidewalls of a Working Chamber.)



(Section of Completed Tunnel.)

FIG. 3. SKETCHES ILLUSTRATING SUCCESSIVE STAGES OF CONSTRUCTION FOR EASTERN HALF OF TUNNEL.

For the building of the second half of the tunnel, Mr. McBean was convinced that he could introduce greater economy by substituting the upper half of the tunnel itself for the heavy timber roof described, especially as this timber structure to be built. The box thus made by the sheeting was about 300 ft. long.

The roof was built in three sections, two 90 ft. long, and one section 84 ft. long. To erect this iron-concrete roof a floating box was first con-

vertical diaphragm of ¼ in. iron plate was so bolted over the ends as to leave a 6 ft. shell-ring outside of the diaphragm. In the center of the top of this projecting ring was a specially provided opening for the use of the diver who was to

...ter this section and do the connecting of two ...in tunnel sections. The cover was left off of ...a opening until the diver had finished his work ...ide. Each 6-ft. ring of the iron shell weighed ...ut 41,000 lbs., and it carried 618 cu. ft. of con... ...te. As calculated, the total weight of the iron, ...ncrete and floor, etc., was about 50 lbs. less per

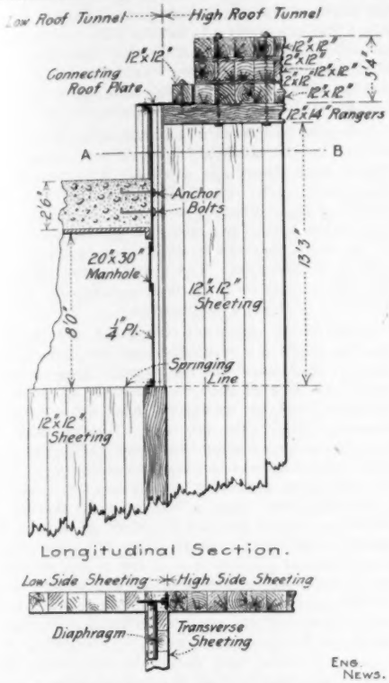


Fig. 4. Sketch Showing Manner of Connecting Old and New Work, at the Center of the River.

lineal foot than the estimated buoyancy of the empty roof-chamber.

The concreting having been completed according to plan, the roof was now ready to be lowered down upon the sheeting sides. The Bronx shore section, 84 ft. long, was the first to be sunk. But before this was done, a short section of the tunnel had been built in an open cut on the shore, provided with horizontal air-locks, and presenting a completed ring for connection, a tight bulkhead having been built over it some little distance inshore of the end before the end of the original cofferdam was removed.

When all was ready for sinking, and suspension tackle had been attached to the eye-bars noted and to heavy beams resting on the service platforms, water was pumped into the box in which the roof had been built until its floor sunk below the false-floor of the tunnel-roof chamber, the buoyancy of the latter having arrested any further sinking of this roof portion. When the clearance was sufficient, one end of the box was removed, and it was pulled out lengthwise from under the roof-portion, and was used in building another roof section. Compressed air was meanwhile pumped into the roof to decrease any leakage through the false floor and to maintain the water displacement. To aid in locating the roof on the sheeting, fine wires were set up at each end of the tunnel section and aligned by a transit, and other tag-lines fastened to the tunnel roof were set for longitudinal and transverse adjustment. With these guides the roof was carefully moved longitudinally until the flanges in the projecting 6-ft. ring coincided vertically with the ending of the shore section; the roof was then weighted with stone to overcome its buoyancy, and was sunk and connected by a diver, as already described. As showing the care taken, the flanges were bolted together by 1 in. bolts entering 1 1-16 in. holes. This section was now ready for excavation, the separating diaphragm being cut, and after the diver had closed the opening by which he entered the projecting ring.

The other two roof sections were assembled and sunk on the sheeting in a similar manner; but the connection of the last section with the river end of the old western tunnel section required some special provisions. As already noted, the timber roof of this first section was placed so high that the entire tunnel section could be built under it, and the lines of sheeting were cut off at a correspondingly higher level. Under this roof a section of the tunnel, about 47 ft. long, was left unbuilt. The problem was to connect the lower iron-concrete roof-section with the high-roof section of the first, or western, half of the tunnel.

The outside transverse bulkhead of the high-roof section was first cut off to the level of the springing line of the tunnel, or to correspond with the sheeting under the new roof. The river end of the last section of the new roof sunk had been closed by a special diaphragm, which had a flanged base at the springing line, which permitted it to rest upon and be lag-screwed to the transverse sheeting mentioned. But the diaphragm itself, instead of conforming in shape to the line of the twin-tunnel section, as before, was now a rectangular plate extending to the full width of the transverse sheeting, or 32 ft. 2 ins., and it was 8 ft. 4 ins. high. To the top of this plate was connected by plates and angles another plate of the same width and almost 5 ft. high. In the lower plate was a manhole, 20 x 30 ins., and angle irons were riveted to both sides and the top of the diaphragm plates, to receive the side plates to be put on after the section was sunk.

After the last section had been sunk into place with this diaphragm attached, the latter was first connected by a diver to the line of transverse sheeting by lag screws. Then, to close a space of about 14 ins. between the line of the diaphragm and the sheeting of the high-roof section, two side plates and a horizontal roof plate were lowered into position, fitted by a diver against the sides and over the top of the roof-rangers and the bolt-holes marked. These plates were then taken up, drilled to correspond with the holes in the diaphragm flanges, and finally bolted to the timber sides and roof by divers. In this manner a water-tight connection was made between the two sections of the tunnel built on different plans, and with this connection complete the water was expelled by compressed air from the old completed tunnel, and the connecting link of the tunnel was built as in the original plan. In the diaphragm as erected, holes had been drilled for the bolts that were finally to connect the flanges of the abutting tunnel shells, and other holes carried anchor-bolts for connecting this diaphragm with the concrete backing.

In the Harlem River tunnel, as here described, two novel systems of sub-aqueous tunneling have been successfully carried out under difficult conditions, and these systems may be employed separately or together, as conditions might require. The advantages of the general plan are apparent. In this case it was applied where the shield method was impossible owing to the lack of a covering, and to the very unreliable character of the soil. The plan permits the adoption of any shape for the tunnel and any reasonable dimensions, and admits of any desired arrangement of conduits outside of the tunnel section proper. As the top of the roof may coincide with the level of the river-bed, or even be above that level, such a tunnel may be located at a higher level than one driven by a shield, with a corresponding economy in lower gradients and consequent operating expenses. The foundation for the tunnel is absolute, as the roof rests on parallel lines of sheet-piling that can be made of any strength and driven to any depth, and inside of the sheeting as many bearing piles may be driven as the case requires, and cut off later to support the tunnel itself. A tunnel so constructed should be perfectly safe against vertical and side pressures and against the disturbing effect of vibration due to passing trains. And finally, as compared with other methods of sub-aqueous tunnel driving, this plan should be especially speedy in permitting a number of points of simultaneous work. The dredging can be followed directly by the sheeting and the laying of the roof, and by putting in bulkheads at intervals the construction of the completed section can follow in its due stage. These are purely the opinions of the writer, as resulting from a study of the work accomplished.

It should be mentioned that this system has been designed and patented by Mr. D. D. McBean, of the firm of McMullin and McBean, and it was carried out with the approval of Mr. William Barclay Parsons, the Chief Engineer of the Rapid Transit Railroad Commission, and Mr. S. L. F. Deyo, Chief Engineer of the Rapid Transit Construction Co., the general contractor for the work. Mr. McBean personally supervised the actual construction, with Mr. Robert Melvin as his Superintendent and Mr. E. B. Naylor as his Engineer.

THE INTERNATIONAL ENGINEERING CONGRESS AT ST. LOUIS.

There was held last week on the Exposition grounds at St. Louis an International Engineering Congress, conducted by the American Society of Civil Engineers. As our readers will remember, the first great international engineering congress was held at Chicago in 1893 at the Columbian Exposition, and similar congresses have since been held at the Expositions at Paris in 1900, at Glasgow in 1901, and at Duesseldorf in 1902.

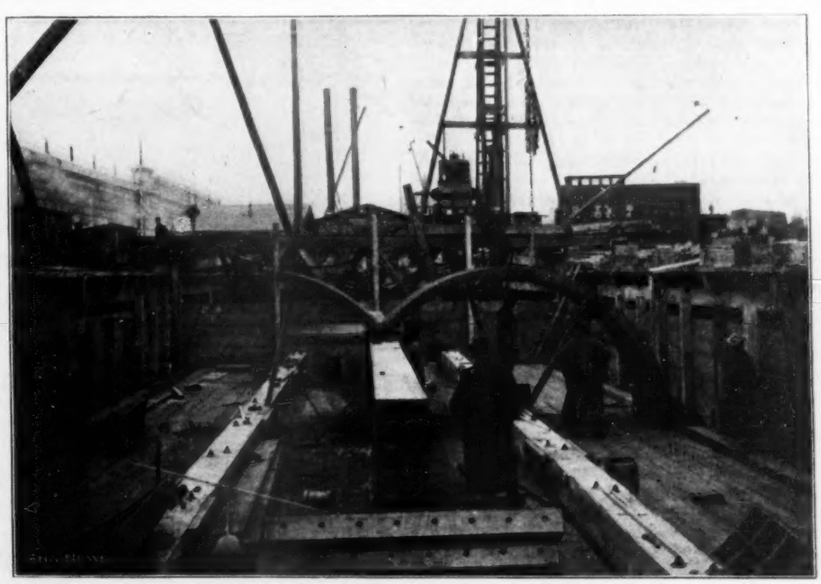


FIG. 5. VIEW SHOWING THE ASSEMBLING OF THE CAST-IRON SHELL INSIDE THE FLOATING-BOX.

It may well be asked, in what way can an en-

gineering congress be made different from an ordinary meeting of an engineering society for the reading and discussion of papers. The general answer has been that such a congress should be more comprehensive and cover a far broader field than that covered by any existing engineering society, and also that the papers presented should attempt to present the existing "state of the art" or to summarize recent progress in some branch of the profession, rather than to present some particular new departure or describe some particular piece of engineering work, as do the papers ordinarily read before engineering societies.

FIG. 6. VIEW OF A COMPLETED ROOF-SECTION INSIDE THE FLOATING-BOX, READY FOR CONCRETING. THIS VIEW SHOWS THE SKEWBACKS, THE END DIAPHRAGM, AND THE PROJECTING 6-FT. CONNECTING RING WITH ITS MANHOLE.

There were prepared for the Congress held at St. Louis last week, nearly 100 papers on engineering topics. Many were of great length, some of them containing 50 to 75 pages of printed matter. Their authors were selected by the committee in charge because of special ability to treat the subjects assigned, and the papers were, as a rule, of a high order of merit. A considerable proportion of the authors, moreover, made an attempt to treat specifically the advances made on their own specialty during the eleven years since the engineering congress held at the Columbian Exposition.

It must be said, however, that while the Congress at St. Louis was intended to cover the whole field of engineering, it fell very far short of doing so, and for the most part the papers presented related only to civil engineering work. For example, we may compare Section A, Waterways, in which there were 20 papers listed, with Section E, Mechanical, which had 10 papers, or with Section F, Electrical, which produced only three papers. Upon the subject of mining engineering, only two papers were presented and they were included under Section H, Miscellaneous.

Had the Congress treated every other field of Civil Engineering work as fully as it treated the single field of Waterways, and had it also covered all the diverse branches of Mechanical Engineering, Mining Engineering and Electrical Engineering with equal thoroughness, it is safe to say that the resultant papers would have amounted to a bulk only comparable to the Encyclopedia Britannica.

The fact is that engineering at the present day covers too vast a field, and includes too great a multitude of diverse arts and industries to permit it to be effectively summarized in all its aspects in the papers and discussions of such a congress as that held at St. Louis.

It may readily be understood also that it is quite out of the question in the space available in these columns to present any complete abstract of the papers which were there presented, covering, as they do, some thousands of pages of printed matter, or of the discussions which took place. Upon the various subjects we shall only attempt in what follows, to give our readers some general idea of the Congress and its work.

The place of meeting of the Congress was in the Administration buildings on the Louisiana Exposition grounds, a group of handsome stone structures which are to be the permanent home of Washington University after the Exposition closes. The first session of the Congress was opened on Monday morning, Oct. 3, with addresses by Mr. Chas. Hermany, President of the American Society of Civil Engineers, who acted as President of the Congress, and Mr. F. J. W. Skiff, Director of the Louisiana Purchase Exposition, who in the absence of President Francis, welcomed the Congress to the Exposition. Mr. Skiff stated that some 400 different Congresses are being held in connection with the Exposition, and he hazarded the opinion that the contributions to American knowledge made through these congresses would exceed in permanent value all the exhibits of material things made at the Exposition itself.

The next address was a notable one by Sir [illegible] White, President of the Institution of Civil Engineers of Great Britain. He referred to the previous International engineering congresses which have been held, beginning with that at Chicago in 1893, and said that this was the first Congress in which the Institution of Civil Engineers, the Nestor among the engineering societies of the world had ever taken an official part. Continuing he paid a tribute to the genius of Capt. Eads, the St. Louis engineer, whose notable feats in connection with the great bridge and the Mississippi jetties made his name famous around the world.

Referring to the claim sometimes made that the worker in the field of pure science deserves a higher rank than the engineer who works for commercial ends, Sir William declared that the results of the engineer's work and the public benefits which had grown out of it proved him to be at the least as great a benefactor of the human race as the scientist. The name of Michael Faraday will always be illustrious; but so also will be the name of George Stephenson.

In the 18th century one man could and did master the whole art of engineering as it was practised at that day. At the present time the profession is divided into a multitude of different branches, and all engineers must be specialists, whether they will or not. Nevertheless, all branches of engineering are closely connected with each other and are actually interdependent, and no hard and fast line of demarkation can be drawn between them. The modern ship could never be created but for the work of the mining engineer, the metallurgist, the civil, mechanical and electrical engineers and the naval architect who combines the results of all the others work.

Referring to the cup won by the yacht "America" a half century ago, Sir William said that it might not be generally known to Americans that although Spears, who designed that yacht, was born in America, his birth occurred only a week or two after the arrival of his mother in the United States, while his father was a native of the same English town as Sir William.

In conclusion, he likened the engineering profession to a great and splendid tree which, with a ramification of roots and branches, has still one single massive trunk.

Following this address came brief speeches from foreign delegates to the Congress representing the French Society of Civil Engineers, the German Society of Engineers, and the engineers of Russia, Austria and the Argentine Republic. The last named engineer, who spoke in English, said that he received his engineering education in this country 47 years ago.

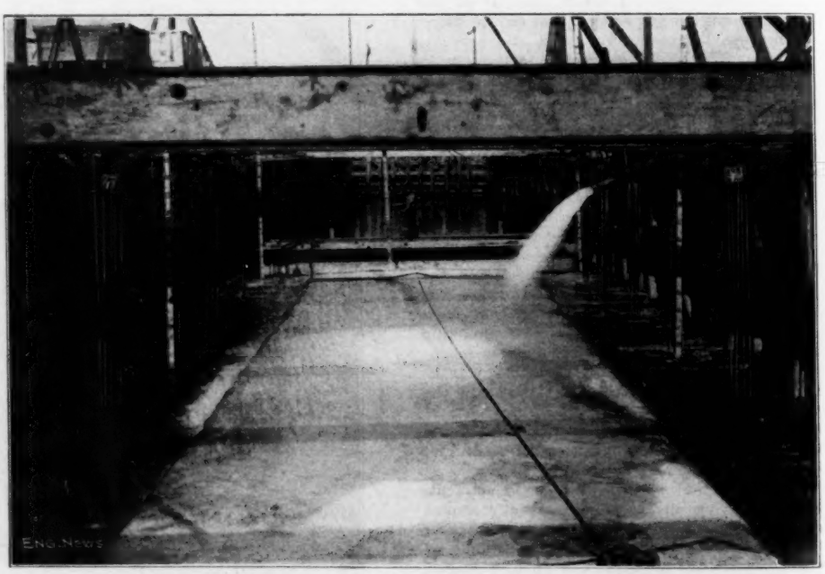


FIG. 7. VIEW SHOWING THE CONSTRUCTION-BOX SUNK BY PUMPING IN WATER; THE ROOF-SECTION BEING SUPPORTED BY ITS OWN BUOYANCY, BY COMPRESSED AIR, AND BY THE SUSPENSION TACKLE SHOWN.

This concluded the opening session of the Congress as a general body, and the following days were devoted to sessions of the several sections of the Congress, the sessions opening each day at 10 a. m., and continuing two to three hours. It may be said here that the total number registered in attendance at the Congress, including the ladies and friends accompanying members, was over 850. It may also be noted that notwithstanding the attractions of the Exposition, the technical sessions were remarkably well attended and the discussions in nearly all the sections were animated and full of interest.

Section A. Waterways.

Mr. Alfred Noble was the chairman of this section, and the first day's session was devoted to papers on harbors, by a number of American and foreign engineers. The three American papers were by officers of the U. S. Engineer Corps: Major C. E. Gillette's subject was the sea-coast harbors of the United States, and related particularly to jetty works and the difficult problem of selecting the method of deepening a channel across an ocean bar. Major D. D. Gaillard and Capt. Dan. C. Kingman dealt with lake harbors, the former taking the harbors of Lake Superior, and the latter those of Lakes Erie and Ontario. Several of the Lake Superior harbors were described, but particular attention was given to that of Duluth and Superior, which is the most important harbor on the lakes, on account of its size, its marine commerce and its facilities for handling vessel freight. A peculiar feature is that after each session's work a hydrographic survey of the harbor is made during the winter, as it is better and cheaper to take soundings through the ice than from a boat on the water. The portions of the borings are laid out on the ice by a transit and steel tape. The boring machines used will cut a 2½-in. hole in 24 ins. of solid ice in 5 seconds. Capt. Kingsman's paper related to methods of pier and breakwater construction, including the use of concrete blocks to form a new superstructure for an old pier. Work of this kind has been described in our columns.

In regard to foreign practice, the paper by Mr. W. Matthews, Chief Engineer of the harbor works at Dover, England, described a number of harbors, and more particularly the great works now in progress at Dover, including the construction of nearly two miles of deep-sea breakwaters and piers, in addition to a sea-wall 3,500 ft. long. The sea structures are all built of concrete blocks weighing from 26 to 40 tons. The concrete is 6 to 1. He favored concrete block construction in preference to monolithic concrete work. In this connection the Japanese papers were read by title: one by Mr. S. Shima on the use of concrete blocks at Osaka, and the other by Mr. L. Hiroi on the manufacture of concrete blocks of harbor work. Island harbors, connected with the shore by open trestles or piers, so as not to check the littoral drift, were discussed in a paper by a Danish engineer, Mr. Vedal, and there were other papers on the harbors of France and Holland.

An interesting but very lengthy description of the harbor works at Buenos Aires and the numerous proposed plans for that harbor was presented by Mr. L. A. Huergo, of Buenos Aires, who has been connected with the development of the port, but does not approve of certain features in the adopted plans. The use of two entrance channels is particularly objected to, but Mr. Corthell thought this arrangement was necessary under the methods of operating the port, and suggested that the paper should be submitted to Messrs. Hawkshaw and Hayter, the British engineers, to give them an opportunity to reply to the criticism.

The subject taken up at the second day's session was that of waterways, and the papers on "Natural Waterways," included one by Mr. Marinkelle, of the Royal Waterways Corps of Holland, on the development of natural waterways in that country, including river regulation and improvement and the improvement of river mouths by the government. Mr. K. E. Hilgard, M. Am. Soc. C. E., now of Zurich, Switzerland, described a peculiar type of rolling dam, which consists of a steel cylinder whose ends ride an incline in the abutments, so that the level of the dam is altered by rolling the cylinder up or down the inclines. There are now two of these at Schweinfurt, in Germany. This type effects the same purpose as the "bear-trap" type of dam, and Mr. Hilgard considers that it has advantages over the latter.

In regard to "Artificial Waterways," a paper by Major Wm. L. Sibert, U. S. Engineers, described a number of canals and river improvement works and also discussed the question of the commercial relations of canals and waterways, in the course of which he stated that he did not think any artificial or natural waterway, here or abroad, could be shown to have worked a material injury to railway interests. Mr. Lewis M. Haupt spoke to the same effect. Mr. W. H. Hunter, Chief Engineer of the Manchester Ship Canal, presented an abstract of his paper, which related specifically to the proposed ship canal across Scotland and the development of the Manchester Ship Canal. The cost of the latter, up to its opening in 1894, was $50,000,000. Since then, $15,000,000 have been spent in widening and improving the channel and especially in improving the railway and freight handling facilities at the terminal docks. While the shareholders have as yet received no dividends, the commercial benefit to the district has been incalculable, and he predicted that dividends would begin within the next seven years, with which view Mr. E. L. Corthell concurred. The last paper was one by Mr. E. P. North, the purpose of which was to show that traffic has developed concurrently on improved waterways and on railways.

The construction and performance of dredges was the subject of four extremely interesting papers presented on the third day, but all were read by title with the exception of the very large one on hydraulic dredging on the Mississippi, by Mr. F. B. Maltby, who read some extracts. Mr. A. W. Robinson's paper described a number of dredges of different types, as well as his new steam shovel. Major J. C. Sanford's paper was on sea-going hopper dredges for work on ocean bars, and the paper by Mr. Hersent briefly discussed general considerations and the construction of several French-built dredges. There was some discussion as to the calculation of the efficiency of centrifugal pumps, and Mr. Sturtevant remarked that too much reliance cannot be placed on theory, as in one case a pump runner was put on the shaft in the opposite direction from that intended by the designer, and yet it gave excellent results before the mistake was discovered. Work on the Mississippi River cannot be contracted for at a price per cubic yard, owing to the influence of the current. Thus where a dredge actually removes 10,000 yds., the current may remove ten times as much, or if the cut is badly located the current may fill it up as fast as the dredge cuts.

A short paper on dock work in New York harbor, by Mr. Bensel, Engineer of the Department of Docks, was rather disappointing. It did not describe the general style of dock construction or the latest style of concrete pier, and a considerable part of the paper described some experiments on the bearing power of piles. In the discussion there was some criticism as to the results stated in the paper.

Section B. Sanitary Engineering.

In the official program this Section was referred to as the Municipal Section; but it really covered only three departments of Sanitary Engineering, viz.: The purification of water for domestic use, chiefly with reference to municipal supplies; the disposal of sewage and the disposal of municipal refuse. The Section was presided over by Mr. J. J. R. Croes, Past President Am. Soc. C. E., and the attendance varied from 25 to 50.

The subject of Tuesday's session was the Purification of Water, which was opened by a paper of 24 pages by Mr. Allen Hazen. One interesting fact brought out by Mr. Hazen was that about 10 per cent. of the urban population of the United States is already supplied with filtered water and filters are under construction which will supply an additional 8 per cent. Mr. Hazen set the average cost of filtration of large municipal water supplies in the United States at about $10 per million gallons, although extremes may reduce that as low as $6 to $8 or increase it from $5 to $20. Advances in the method of washing and handling the sand have greatly reduced the cost of operation of filters. In the design of mechanical filters the change from the pressure to the gravity type and the use of large coagulating basins have been among the notable improvements.

Besides Mr. Hazen's paper, M. Bechmann, Chief of the Paris Water Department, contributed a paper on French practice in water purification, from which we gather that general practice in France is extremely backward in this branch of engineering. Filter galleries and various patented processes of water treatment appear to have engaged the attention of French engineers and there are only a few slow sand filters and practically no mechanical filters of the American type in use in France for municipal supplies, although some are in use in industrial plants. A second paper, by Dr. Adolph Kemna, Manager of the Antwerp Water Works Co., referred also to the long maintained hostility of French engineers and scientists to water filtration processes and to the recent change of opinion within a period of not more than three years. A fourth paper by J. M. K. Pennik, Director of the Water Supply of Amsterdam, Holland, described the investigations made in selecting sources of ground water supply in the sand dunes along the sea coast from which Amsterdam draws its water.

Among those who took part in the brisk discussion upon this subject, were Messrs. Chas. G Durlach of Philadelphia, J. N. Chester of Pittsburg, Prof. Olin H. Landreth of Schenectady, Prof. Gardner B. Williams of Ann Arbor, E. B. Weston of Providence, R. I., and W. B. Fuller of New York City.

Mr. Chester said that the mechanical filtration plants of 15 years ago were capable of working with high bacterial efficiency. The American Water-Works & Guarantee Co. has two filtration plants at Chattanooga and Little Rock, which have been in service 15 years, which are showing as good bacterial results as plants just built. The improvements which have been made in mechanical filters have been chiefly in their construction, to give greater ease and certainty of operation and diminished expense for repairs. Mr. Hazen had referred to the mechanical filter as chiefly adopted to sediment-carrying waters, but in his experience it was often necessary to adopt mechanical filters in smaller places on account of inability to find a suitable location for filter beds or suitable material for their construction.

Mr. Weston said that in selecting a source of supply where filtration was not to be used, much attention should be paid to the appearance of the water. A water may be all right in every other way, but if it is objectionable in appearance, people will reject it and use purchased spring and well water of uncertain and often of objectionable character.

Professor Williams alluded to the fact that a person accustomed to drinking polluted water appears less susceptible to its effects than a person accustomed to pure water. Since people will travel, those living in towns supplied with pure water become more apt to contract disease when they are abroad. Hence, if we purify water at one place we ought eventually to do so at all places. He also pointed out that the benefit of pure water is not measured alone by the reduction in typhoid. He had found that statistics showed when mortality from typhoid was high, mortality from other diseases was high also.

On Wednesday's session the disposal of sewage was the subject discussed, the papers presented being by Messrs. Geo. W. Fuller of New York City and M. Bechmann, Chief Engineer of the Paris water-works and sewers. Mr. Fuller discussed American sewage disposal. He found that of the total urban population of the United States, estimated at about 28,000,000, about 6,500,000 discharges sewage into salt water, about 20,400,000 into inland lakes and rivers, and the sewage of only about 1,100,000 is purified before discharge. There are now about 85 sewage purification works in operation in the United States, of which 65 have been built in the past 10 years. Mr. Fuller fully reviewed the different process of sewage purification and the results of experience with them

and his paper, which contained nearly 50 pages, really constitutes an admirable little treatise upon American practice.

Interest was added to the discussion upon this paper by the participation of some of the English members of the Congress who were connected with the Local Government Board of Great Britain. One of these visitors said that in England the choice for sewage disposal usually lies between a contact bed and a percolating filter. Alluding to the large water consumption in the United States and its effect on the sewage disposal problem, he suggested that one reason for the large consumption was the waste through defective plumbing fixtures. In England it is customary to permit the use of only such fixtures as are inspected and officially stamped.

Mr. Rudolph Hering remarked that where a large city like New York polluted oyster beds by its sewage, the oyster beds would have to go, since it was impossible to dispose of the city's sewage otherwise than by direct discharge. At Baltimore, however, where the oyster industry is a much larger interest and where sewage purification is feasible, it might be advisable to adopt it. It is probable that within a year the city of Columbus, O., will have in operation the largest sewage disposal plant in the United States, and it may establish an important precedent with respect to the disposal of the sewage of inland cities remote from large rivers. So far as the scientific basis of sewage treatment is concerned, he did not think the United States was to-day in any respect behind Europe.

Mr. E. B. Weston said it was common to think and speak of exposure to the air as oxidizing sewage. Actually, the only oxidation of sewage is effected through bacterial life, which requires air for its support.

At Thursday's session the refuse disposal of cities was the subject, and was opened by an exhaustive paper of 43 pages by Mr. Rudolph Hering. We take space for the following summary with which the paper closed:

After years of experience in England, and several careful and thorough examinations and trials made in both England and Germany, the following conclusions have there been reached:

First.—In no European city is the grease sufficient in quantity to warrant the cost of its extraction;

Second.—In England the amount of combustible matter is generally sufficient to burn the refuse and produce steam without the constant addition of fuel;

Third.—In Hamburg the same condition exists; and

Fourth.—In Berlin the refuse contains enough fuel to burn itself during the summer months, but in winter it can only be burned by the addition of coal; sifted Berlin refuse will burn at all times, but not at economical cost. So far as the writer knows, the Berlin refuse disposal question has not yet been finally settled.

The most important questions for solution in the United States now are:

First.—The extent to which reduction works are satisfactory and economical. In the largest of our American cities the amount of wasted fats and oils has been sufficient to pay for extraction. The question yet before us is the limit down to which it will pay, and the lowest profitable price for the grease.

The extraction of grease is but a part of the refuse disposal. There are also other parts, and the further question remains as to the total economy of properly disposing in addition all these other parts.

Second.—The question as to the most effective and economical crematory in order to burn all or some parts of the refuse. In Europe there are several of such refuse destructors which for efficiency and economy have stood the test of years. It is true that they may be less efficient for American refuse. The adoption of the English furnace in Montreal and San Francisco has not met with the same perfect success which is recorded in Europe. Yet the history of American types of furnaces has not been any more encouraging, and in a number of instances even less so. The question of comparative cost, on the basis of both wages and combustibility of material, in Europe and America, also indicates that America has room for improvement in the methods of refuse cremation.

Third.—Present English practice indicates that the utilization of heat from refuse destruction promises to reduce its cost and make the works more efficient. To utilize ecoromically the power in the United States would require the addition of auxiliary grates upon which to burn coal for steaming when the efficiency of the refuse for this purpose falls short. The question arises as to how far this is economically practicable.

Fourth.—The question as to how far the refuse shall be separated and collected in different receptacles, depends on the adopted method of final disposal. The fact that even a large city can change from a combined to a separate system of collection without serious trouble, which is a more difficult change than the reverse, was demonstrated a few years ago by the city of New York. Dependent further on what is to be done with the different parts of the refuse, is the decision as to which parts, if any, can be combined, which decision again determines for each the best intervals of collection.

Fifth.—A decision regarding the most economical final disposal must also depend upon a more accurate knowledge than yet exists of the character, analysis, relative quantities and seasonal variations of the materials making up the refuse.

With the above questions satisfactorily answered, the writer believes that the art of collecting and finally disposing of the municipal refuse of American cities will be materially improved.

In the discussion, Prof. O. H. Landreth said that classification of city wastes before collection was essential, in this country at least, to any successful disposal. In all American cities where wastes are collected, from one to four classes of wastes are made. The most common plan is to make three classes, viz.: garbage proper, commonly called swill; combustible material, such as paper, rags, and wood; refuse and ashes and incombustible material, such as old metal, glass and tin cans. Experience shows that in this country wastes can be handled more economically with separation than without. As respects the cremation of garbage proper, the material contains about 80 per cent. water, 10 per cent ash and 10 per cent. combustible material. Excluding the ash, if the stuff were to burn itself, 1 lb. of combustible would have to evaporate about 8 lbs. of water, which would be a pretty good record for a steam boiler where the fire is all in the furnace and the water is separated from it and every condition is favorable to combustion. In a garbage furnace no such advantageous conditions are present, and if American garbage is to be successfully cremated, fuel must be added in most cases at least.

Regarding disposal of combustible wastes, it is noteworthy that Buffalo has recently let a contract for a furnace to burn combustible refuse to raise steam to run a sewage pumping station.

Section C. Railways.

The chairman of this section was Mr. Robert Moore, M. Am. Soc. C. E., and the proceedings opened with the presentation, in abstract, of three papers on railway terminals by Mr. E. L. Corthell, M. Am. Soc. C. E.; Mr. W. T. Foxlee, of England, and Mr. Ernest Pontzen, of France. Mr. Corthell was the only one of the authors present, and his paper presented a description and comparison of a large number of passenger terminals in the United States and Europe, with a detailed tabulated list of information respecting 24 stations. Mr. Foxlee's paper consisted mainly of descriptions of a number of individual passenger and freight stations in England, and also three terminals at seaports. The discussion was opened by Mr. A. P. Greensfelder, Assistant Engineer of the Railroad Terminal Association, of St. Louis, who gave further details of the improved facilities of the great union station at St. Louis, which were described in our issue of Sept. 29. He also remarked that in planning station facilities it must be remembered that people in crowds easily get confused. Mr. Corthell referred to the great convenience of the baggage checking system in the United States, as compared with European practice, where the passengers' trunks and hand baggage are equally conveyed in cabs and all deposited at the station in the same place, causing great confusion. On the other hand, some stations in France have excellent arrangements for the mechanical handling of baggage between the baggage rooms and trains. European stations usually have wide and solid platforms, ample provision of subways connecting the platforms, and signs for the information of passengers. Mr. G. W. Parsons remarked that in Europe these signs are also large and easily read, while in this country they are too few and too small. Mr. E. E. R. Tratman (Associate Editor of Engineering News) referred to the great extent to which English railways prevent the fouling of tracks at junctions by means of "flying junctions" where the tracks are so arranged that the less important line (either for a branch or a freight yard connection) passes under or over the main tracks. At passenger terminals the relative location of car cleaning and storage yards, engine facilities, etc., is most important as regard to the convenience and economy of operating the terminal, while at large freight terminals economy in space can often be secured by the use of freight houses of two or three stories, served by elevators. As to baggage arrangements, while the American system of checking is excellent, foreign railways have the reputation of handling the baggage with far less damage than is sustained here. This is simply a matter of discipline, but seems to receive very little attention. Mr. Corthell, in replying to some enquiries, said he thought 15 ft. should be a minimum width for platforms, and 1° the minimum curvature fo the approach to a station, but, of course, local conditions may often prevent these figures being followed.

Underground railways formed the subject for the second meeting, and three paper by Mr. Wm. B. Parsons, Mr. L. Biette and Messrs. B. Mott and D. Hay described the practice followed in the United States, France and Great Britain, respectively. Mr. Robert Moore called attention to the important matter of the relations between the railways and the municipality. In this country and in England the work is done by private enterprise, while in Paris the city undertakes the actual construction work. Mr. Tratman pointed out that in New York a special commission had determined upon the routes and the general character of the construction. In London the companies work for their own individual benefit rather than for that of the general transportation problem of the city, so that any new line is violently opposed by any other lines which anticipate interference with what they regard as their own territory. The city is also antagonistic to the new lines. The result of this lack of system has been so chaotic that about two years ago a special commission was appointed to investigate the entire problem of city transportation for London, and meanwhile new projects have been held in abeyance. As to the operation, the serious vibration caused by the trains of the Central London Ry. have led to the abandonment of electric locomotives and the adoption of the multiple-unit motor car system. Mr. Camp referred to the proposed electric operation of freight traffic in the Chicago deep-level tunnels originally built for the cables of the automatic telephone service, and Mr. Woodward described the project for a four-track underground line connecting the five railway stations at Cincinnati. He remarked that at New York, the clearance between the roof of the car and the roof of the subway is only 4 ins., which would be liable to result in a bad jam in the event of a wreck. He also pointed out that none of the foreign works appeared to provide for electric cables or conduits.

On the third day a paper on "Live Loads for Railway Bridges," by Mr. H. W. Hodge was presented; the author considers it unwise to use a load of less than 50,000 lbs. per driving axle, followed by a train load of 5,000 lbs. per cu. ft., as such loads will be quite universal in the near future, and are already exceeded on several lines. The ventilation of railway tunnels was discussed in two papers by Mr. Francis Fox, of England, and Mr. C. S. Churchill, Chief Engineer of the Norfolk & Western Ry. Both referred to the use of the Saccardo system of using an air blast on the principle of the injector, and it was pointed out that tunnels operated by electricity required ventilation as well as those operated by steam. Mr. Fox stated that if railway engineers would adopt for tunnels the same rules as are applicable to mines, much of the difficulty in ventilation would disappear.

Section D. Materials of Construction.

This Section of the Congress was presided over by Mr. F. P. Stearns, M. Am. Soc. C. E., of Boston, and was probably the most largely attended of any of the sectional meetings. The session of Tuesday opened with a paper by Wm. Metcalf of Pittsburg, Past President of the American Society of Civil Engineers, on the Manufacture of Steel. The paper was a very brief comparison of the production of steel in 1892 and 1902, showing advances in the decade in capacity, quantity and

quality. Regarding tool steel, in which Mr. Metcalf speaks with greatest authority by virtue of his long connection with the Park Steel Co., it is of interest to note his statement that there has been no improvement in the finest grade of crucible tool steel in the last 40 years. Ordinary grades of tool steel which sold forty years ago at 14 to 16 cts. per lb., are now sold at 6 cts. per lb., or less, leaving only the very finest grades not improved upon and not much reduced in price. The following extract from Mr. Metcalf's paper is of especial interest:

High-speed steel is the one remarkable, revolutionary development of the decade. In the necessary heat treatment it reverses nearly all the best practice for carbon steel; and in its work it has practically revolutionized the machine business of the world. As far as it is developed at present, it consists usually of medium carbon, generally under 0.80, very little manganese, from 10 to 20% of tungsten or molybdenum, and generally from 3 to 4% of chromium, although some brands do not contain chromium. It is hardened by heating almost to fusion and quenching in an air-blast or in cold oil.

It will make heavy cuts at a remarkably high speed for metal working, hence its name, causing a temperature that will blue steel chips and that would ruin instantly any carbon steel tool. To predict what may be the final outcome might lead to the idea that one had let his imagination run wild; certainly the results are already startling.

Next came a paper by Prof. Bradley Stoughton, of Columbia University, entitled "Notes on the Metallography of Steel, and this was followed by a long and very valuable paper on the Manufacture of Cement by Mr. Robert W. Lesley. Few industries in the engineering field can show a growth for the decade compared with the cement industry, and Mr. Lesley, as one of the pioneers in the manufacture of American Portland cement, was awarded the pleasing task of reporting to the Engineering Congress the growth of the American Portland cement industry from 547,000 barrels in 1892 to 17,230,000 barrels in 1902. His paper reviews in a clear and terse manner the revolutionary changes which have taken place in the cement industry, its machinery and methods in the past ten years, and it may be noted here that he ascribes to the rotary kiln and the use of improved grinding machinery the chief credit for the phenomenal growth of American cement production. He also obtained from Dyckerhoff, of Germany, and from Candlot, of France, statements which were incorporated in the paper of present practice in Portland cement manufacture in Germany and in France, respectively. It may be noted that there are about 50 rotary kilns in use in Germany, 40 in England and about 12 in France.

On Wednesday the subject of Concrete and Concrete Steel was taken up by Section D, the papers presented being by Messrs. Edwin Thacher. Capt. John S. Sewell, Fr. von Emperger, Armand Considere and J. J. L. Boudrer. All these names are so well known to those interested in concrete steel construction that it need hardly be said that these papers form an extremely valuable summary of the state of this comparatively new art. The following extract from Capt. Sewell's paper is one of the most admirable answers to current criticisms of concrete-steel construction that has anywhere appeared:

Reinforced concrete, especially where it includes the girders and beams, has been introduced in this country under many adverse conditions. Inspectors of buildings in municipalities, and many engineers, have demanded of it a factor of safety at least twice as great as that demanded of steel. This makes the cost prohibitive; if such a large factor of safety is really necessary, the material itself is unfit for resisting transverse strains at all. Many cases have occurred where a building inspector has demanded that large floor areas be loaded with six times the working load, including the weight of the construction itself. If the floor did not collapse, it was accepted, and allowed to stand! If it collapsed, the entire work was condemned! In other cases, an engineer has demanded that the floors of a building be designed with a factor of safety of four, based on the total dead and live loads, the elastic limit of the steel, and a very moderate assumed ultimate strength of concrete. The requirements, in both cases, were prohibitive; if justified by facts, it would mean that reinforced concrete is entirely unfit for such uses.

It is justifiable to demand of a new type of construction that it shall demonstrate repeatedly and on a large scale, that it has at least as high a factor of safety as that which it seeks to displace; but to demand of it a very much higher factor is unreasonable; it tends to encourage poor work, and is an indication that factors of safety in the prevailing types are too low, or that the new construction has defects that unfit it for any use at all.

The elastic limit of good medium steel in the United States is about 40,000 lbs. per sq. in. The usual working stress in a building is 16,000 lbs. per sq. in., so that the factor of safety, based on the elastic limit is 2½. There is little doubt that if the elastic limit in steel beams and girders is exceeded, the deflection would cause the collapse of nearly every form of floor arch or filling in common use in America; so that the factor of safety does not exceed 2½, even though the steel might hang together, after the stresses pass the elastic limit. But there is another point that is often overlooked; designs for steel frame buildings may show excellent details; but the writer knows, from personal observation, that this excellence in design is largely nullified by indifferent and even criminally reckless work in the field, unless supervision is very close, and this is not often the case. Consequently it is doubtful whether many of the modern steel-frame buildings would stand up if fully loaded, even up to the limit assumed for a safe working load. Fortunately they almost never receive any such test. The inspection of erection work on a lofty steel frame is difficult, dangerous and disagreeable; but the writer has done enough of it to know that if the riveting gangs could remember and would tell all that they know, many engineers who have turned out most excellent designs, but who have not had the opportunity to inspect the work in the field, would have many anxious moments. It is often claimed that the opportunities for poor work in reinforced concrete are unusually great; the writer cannot agree with this. One reasonably intelligent inspector at moderate wages can insure a proper mixture of concrete on a large work, especially if machine mixing be required. Another can insure the proper placing of the steel reinforcement. Against everything else, the concrete protects itself. The economy of reinforced concrete will much more than pay the cost of inspection.

Capt. Sewell advocated the use of the term "Reinforced Concrete," and discarding of the term "Concrete-Steel"; but a difference of opinion developed concerning this in the discussion.

Regarding the feasible limits of span with reinforced concrete, Mr. Thacher said that he did not apprehend any trouble in making arches of spans up to 500 or 600 ft., provided only that sufficient rise could be given and be believed such structures could be built as cheaply as steel structures.

With reference to the quotation from Capt. Sewell's paper printed above, an English member stated that in England the municipal building ordinances were a great obstacle to the introduction of reinforced concrete. It was easy to convince the building inspectors that a proposed construction was safe; but they had no option to accept anything but what the local building ordinance demanded.

The discussion on this subject was so active that it was not completed on Wednesday, and it was therefore continued at the last session of the section on Friday. Mr. A. L. Johnson presented a strong argument for the adoption of a mechanical bend between the steel and the concrete instead of depending on adhesion alone. He pointed out that any stretch in the steel must be accompanied by a reduction in section of the steel which must inevitably separate it from the concrete. He submitted that most tests on reinforced concrete beams are made with static loads, and it does not at all follow that under the shocks of actual service the steel and concrete will not separate. He cited a case where a reinforced concrete floor in a glue warehouse in St. Louis failed after ten years' service. The floor was only 8 ft. span and 6 ins. thick, and the loads were light; but the engineer relied entirely on the adhesion of the steel and the concrete. It is true that foreign practice has been to rely entirely on the adhesion, but we have had longer practice in concrete steel beam construction here than abroad.

Regarding variable results as respects cracks in reinforced concrete under strain, he said that concrete when "bone dry" has high ultimate strength, but much less extension before rupture than concrete containing a moderate percentage of moisture. The latter will stretch enough to give it a much greater resilience to absorb shock than the dry concrete.

Tests of Materials of Construction was the subject taken up by Section D on Thursday, and five papers were presented, the authors being Wm. R. Webster, of Philadelphia, and L. Bacle, of France, on tests of steel. W. A. Aiken, Inspector of Cement for the New York Rapid Transit Ry. on tests of cement. Edward Candlot, of France, on tests of cement and other non-metallic materials, and Prof. Gaetano Lanza on tests of timber.

Mr. Webster reviewed the work done by the engineering standards committee on Great Britain and of the American Society for Testing Materials in this country, and emphasized the importance of the correct heat treatment of steel. He also exhibited a simple and practical method of making a microscopic examination of the structure of finished steel by slightly etching a small polished surface of the metal. The following extracts from Mr. Webster's paper are of particular interest:

Most of the old and some present specifications for bridge material contain a provision that when the material is to be annealed, the test piece is to be similarly treated. This is all right for forgings or castings where the test piece is annealed at the same time as the casting or forging, but when it is applied to flats for eye-bars it is a very different matter, and has led to all sorts of trouble. Bars which had been finished very hot in rolling, and which would have failed under the ordinary tension or bending test, when carefully annealed met all the requirements specified, and the material was accepted on such tests. The bars after being upset and headed are annealed by methods which can hardly be called perfect. Full-sized tests of eye-bars have shown very different results from those of the small test piece; the bars breaking in the body or the head with little or no reduction of area, poor elongation and granular structure. This trouble increases with the size and thickness of the bar and has been a great drawback to the use of larger eye-bars. This old blanket clause has been one of the most injurious that was ever put into a specification, and only in recent years has it been replaced by one calling for cold bends to be made on the material in the condition it leaves the rolls, i. e., without annealing. Some specifications also call for a tension test of the annealed test piece, others do not call for this, it not being considered necessary.

The general use of very large eye-bars has been made possible by insisting that material should meet the requirements of the cold bending test made on pieces of the full thickness of the bar. In order to meet this requirement it is necessary to put enough work in rolling on the bar at a low temperature to elongate the particles and make a tough steel; otherwise it will fail under this test.

The acceptance of steel on the chemical analyses alone has never been advocated, yet some of our railroad companies are doing this on driving axles for locomotives. Others are taking a tensile test of the bloom from which the axle is to be forged; but in both cases the axles are forged and put into service without being annealed, and no physical tests are made of the finished axle. This has been done notwithstanding all that is known of the injurious changes in the structure that may be produced by heat treatment and also that the large mass of metal in a driving axle is much more liable to be injured than in the small truck axles which are tested under the drop. It is almost incredible that such practice exists with all the information so readily accessible to the manufacturer as well as to the engineer and railroad official.

The different committees at work to-day in this country on the testing of steel and specifications are endeavoring to find better check tests on brittle steel, to prevent its being accepted and put in service.

Mr. Aiken reviewed the recent changes in cement testing practices as follows:

The two most marked changes in practice of late in testing cement are:

First.—The recognition that the place to do the testing is at the place of manufacture, which insures more satisfactory sampling and therefore a more uniform quality of accepted material as well as more uniform test results since these are made always by the same operators. This method insures also the additional gain of a complete supervision of the process of manufacture, which, in the light of experience, is certainly a controlling element in a good finished product.

Second.—The marked tendency toward lowering the specification strength requirements in both neat and sand mortar tests at early periods.

In addition to these the tendency toward requirements for increased fineness in the product may be mentioned. This, in the writer's opinion, will result finally in a specification covering this quality in the raw mix as best solving the question of proper clinkering.

The continued failure to crystallize opinion as to the entire efficiency of any accelerated test for the determination of the quality of soundness should be noted also. Most engineers are still unwilling to waive entirely such requirement, and the lately proposed "standard cement specifications" do contain an accelerated test, less severe than the extreme boiling test, but undoubtedly a concession to its advocates. However, the inspection and testing of cement at the mills, where the product is held for 28-day tests before final action is taken, may relieve some of the friction growing out of the continued insistence

on even the severest accelerated test, since, under this condition, certainly no such test need be made until the expiration of 28 days, thus giving the material opportunity to aerate if the tendency toward "unsoundness" when fresh is due solely to the presence of excess of free lime.

Prof. Lanza's paper was a review of the history of timber testing, and included a useful bibliography of timber testing literature.

Among those who took part in the discussion on steel testing, was Sir Wm. White, who emphasized the importance of the ordinary bending test as a means of determining the actual character of material and detecting any dangerous brittleness. Prof. Lanza in a written discussion urged that a greater number of tests on full size members of various forms should be made and put on record for the use of the profession.

Section E. Mechanical.

In this section, the chairman of which was Mr. Haines, M. Am. Soc. C. E., the first meeting was devoted mainly to locomotives. Mr. Wm. Forsyth, M. Am. Soc. M. E., presented a paper reviewing the development of the locomotive in America during the first decade and forming practically a supplement to the paper presented by the late Mr. D. L. Barnes at the Engineering Congress in Chicago, in 1893. The growth of the number of types was mentioned, but among these the Prairie, or 2-6-2 type, was overlooked. The several American four-cylinder balanced compounds were also described, all of which have already been illustrated in our columns. The width of fireboxes for bituminous coal has been increased to 5, 6 and even 7 ft., and the front water leg inclined forward. The tendency to crowd as many tubes as possible into the boiler is giving place to a wider spacing in order to obtain greater boiler capacity. In two lots of passenger engines built to the same plans, one has 328 tubes and the latter 245, with a reduction of 25 per cent. in heating surface, but with an improved circulation and increased efficiency of heating surface. He considered that the maximum size of firebox consistent with proper firing by hand had been reached, and that any further increase, to be economical, must be accompanied by the use of oil fuel or mechanical stokers. Piston valves are in general superior to flat slide valves, and with equal attention will leak less than the latter, contrary to general opinion. The use of the Walschaert valve gear on the fast passenger engine of the Pennsylvania Ry. and the powerful freight engine of the Baltimore & Ohio Ry. is a matter of interest and importance, and the gear has several advantages over the link motion, the parts of which are now in many cases inordinately heavy. As to frames, there is still very much room for improvement as breakages of both wrought iron and cast steel frames are as frequent as ever. A short paper by Mr. E. Sauvage reviewed modern French practice, and dealt particularly with the extensive use of the four-cylinder balanced compound. In the majority of these engines the high pressure cylinders drive one axle, and the low-pressure cylinders drive another, the wheels being coupled, however, in the usual way. An interesting class of engines of this type is represented by some powerful tank engines designed for rapid acceleration in suburban service and also for freight service.

A paper by Mr. J. O. Handy, Chief Chemist of the Pittsburg Testing Laboratory, reviewed methods of "Purification of Water for the Production of Steam." The paper related to locomotive work, giving the cost of treatment by different methods, and showing the advantages of treating the water before it is delivered to the engines. The cost of treatment is not always of the first importance, as results in increasing the service of the engines and reducing the expenses of boiler repairs must be considered.

On the second day, a paper by Mr. Gardner S. Williams, M. Am. Soc. C. E., on "Turbines and Water Wheels," was presented. This described the development and tests of turbines and impact wheels. The present efficiency of the latter is about 86 per cent., and anything beyond this must be gained in the bucket. The author's closing remarks were as follows:

> The fifth stage in the development of American water wheels is represented in the recent reapplication of the principles of the Boyden and Francis wheels to high heads and large powers, and, while the commercial results attained are highly satisfactory to the builders of wheels, the data of reliable tests of wheels of these types have not yet come into the possession of the writer. The fact remains, however, that, while only a few years ago Americans were forced to purchase machinery for such service abroad, the demand is now being very largely filled by American-designed and American built wheels, some of which are giving better satisfaction to-day than their European predecessors.

Another paper presented was on "Passenger Elevators," by Mr. Thomas E. Brown, M. Am. Soc. C. E., which was an extended review of the development of the modern elevator and its appliances. On the third day, a valuable paper on pumping machinery by Mr. Irving H. Reynolds, was presented, reviewing present practice. The conclusions were as follows:

> It is the writer's opinion that within the next ten years the economy of the present types of pumping engines may be increased about 10%, due to the use of higher pressure, superheat and the utilization of the heat in waste gases, and that within that time there is little likelihood of either the steam turbine or the gas engine superseding the reciprocating steam engine in general water-works service.

A paper by Mr. W. M. Venable discussed the principles of design of "velocity pumps," including centrifugal, screw and turbine pumps; and Mr. F. Hodgkinkinson's paper described some typical tests of steam turbines, with their results.

Section F. Electrical.

In this section, of which Mr. Frank J. Sprague was chairman, two papers discussed the substitution of electricity for steam as a motive power, but neither of these considered the substitution of electricity for steam on main lines as at all probable. Mr. J. G. White, M. Am. Soc. C. E., of New York, looked for a considerable development on suburban and interurban lines, even those of the large railways at such cities as New York, Chicago, etc., but as to regular main line operation he presented the following conclusion:

> The conversion of main trunk lines and freight roads does not deserve serious consideration, except in rare instances, where increased capacity is urgently needed, and not otherwise attainable at reasonable cost, or if operating through frequent or long tunnels.

The conclusion presented in the paper by Mr. Alexander Siemens, of London, was to the same effect, being as follows:

> The conclusion to be drawn from the consideration of the relative position which steam engines and electric motors occupy at present, appears to be that it is more correct to regard the one as the supplement of the other rather than to expect a complete substitution of electricity for steam as a motive power.

An elaborate paper by Mr. L. B. Stillwell, M. Am. Soc. C. E., reviewed the progress in the generation and distribution of electricity, including the systems in general and the apparatus required.

Section G. Military and Naval.

In this section, of which Col. Wm. P. Craighill, M. Am. Soc. C. E., was chairman, there were three papers on ordnance: 1, on guns, by Capt. O. C. Horney, U. S. A.; 2, on gun carriages, by Capt. E. P. O'Hern, U. S. A.; and 3, on ammunition, by Capt. T. L. Ames, U. S. A. In the first of these, reference was made to different types of wire-wound guns, and the view was expressed that there is no good reason why such a gun may not be made to fulfill all the necessary requirements as to longitudinal and transverse strength, while the ease and certainty with which the initial strains can be regulated are strong points in its favor. Major Goethals, U. S. Engineer Corps, in his paper on "Fortifications," stated that appropriations for coast defense work are becoming smaller, but that the greatest danger lies in the insufficient number of properly trained men to fight the guns, the coast artillery branch of the service being too small in numbers to man the guns now available.

The papers by Sir William H. White, President of the Institution of Civil Engineers, on "Naval Architecture," and by Mr. W. F. Durand, M. Am. Soc. M. E., on "Marine Engineering," were exceedingly interesting reviews of their respective subjects, but we have space to refer only to one point of each paper. Sir William White stated that the boiler committee of the British Admiralty has recommended the exclusive use of water-tube boilers in all naval vessels, thus abandoning its former stand in favor of retaining a certain number of Scotch boilers to ensure economy in cruising service. Mr. Durand, in discussing the steam turbine, pointed out certain disadvantages which are often overlooked in comparing the turbine with the reciprocating engine for naval work. The former is less adapted for warships than for commercial vessels, as in the former power is mostly developed at low rates for cruising, while in the latter the power is developed at full rates and consequently under conditions more favorable to economy. Sir Wm. White, in discussing a paper on marine engineering by Japanese engineers, remarked that the instruments there used to record the vibrations of warships due to the engines, were practically the same as those used to record earthquake vibrations. It may be of interest to note that one of the Japanese exhibits at the St. Louis Exhibition comprises a number of similar instruments for recording vibrations in bridge members, etc.

On the third day, three papers were presented in regard to lighthouse practice in the United States, Great Britain, and France. Also short papers on dry docks in France and England, and a third on "Temporary Dry Docks for Rapid Construction." The last was by Prof. Timonoff, M. Am. Soc. C. E., of the Institute of Ways and Communications, St. Petersburg, and suggested the use of natural or artificial basins with rock-fill embankments made watertight by an outer bank of earth, and having a deep bed of sand to receive the ship and so avoid the necessity of using keel blocks. Such constructions are intended for emergency repairs to both warship and commercial vessels. There was a long and interesting discussion as to the merits of timber and masonry construction for dry docks and it was shown that the U. S. Navy Department is now building only concrete docks. Sir Wm. White reviewed the several papers, and did not think Mr. Timonoff's ideas very practicable. He also discussed the relative merits of fixed docks and floating docks, and referred to the cases of docking injured warships.

Section H. Miscellaneous.

The sessions of this section were more slimly attended than those of any other section of the Congress. The reason for this was not apparently any lack of interest in the subjects discussed but the fact that the sessions were not held like those of the other sections in rooms in the Administration building, but in the Swedish pavilion a short distance away. The chairman of this section was Mr. Octave Chanute of Chicago, Past-President of the American Society of Civil Engineers. At the opening session on Tuesday morning, the subject for the day was irrigation which was opened by a paper by Mr. Elwood Mead, Chief of the Bureau of Irrigation Investigations of the Department of Agriculture. Mr. Mead presented his paper in person and in so doing laid particular emphasis on the fact that irrigation is not so much a problem of engineering as a problem of law, and that the progress of irrigation has been hampered more by unwise legislation or by lack of wise legislation to govern the equitable utilization and distribution of water than by any lack of ability to solve the engineering problems presented. Mr. Mead said further:

> The tendency to magnify the construction side of irrigation is still manifest. While we may not give too much attention to problems connected with dam and canal building, we fail to give enough to those connected with the agricultural and economic sides. It is the work of the farmer which, after all, determines the value of irrigation properties. Few understand the outlay required to prepare wild land for the distribution of water and how important it is that the right method of application be adopted. The financial failure of many meritorious projects has been due to not realizing the expense which farmers must incur in grading land, removing sage brush, filling up gopher holes and building checks, dikes and furrows for applying water to crops. It is this expense which delays reclamation and reduces returns from water rentals.

From the statistical point of view, Mr. Mead showed that there are now about 10,000,000 acres of irrigated land in the United States and nearly 60,000 miles of irrigated canals and main

(Continued on page 336.)

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Entered at the New York Post Office as Second-Class Matter. Published every Thursday at St. Paul Building, 220 Broadway, New York, by

THE ENGINEERING NEWS PUBLISHING CO.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE, 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50: 10 weeks, $1.00. To all other countries in the Postal Union: Regular Edition. One Year, $8.00; Thin Paper Edition, One Year, $6.75. SINGLE COPIES of any number in current Volume, 15 cents.

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A recent specification for riprap states that payments will be made per ton of 2,240 lbs. There seems to be no good reason for using the long ton as a unit of rock measurement when the short ton and the cubic yard are so widely accepted as being the most convenient units. It is true that in weighing iron ore the long ton is still used, but, on the other hand, the short ton is used for all ores of the precious metals and for ores of lead, zinc and copper. The long ton is used at the anthracite mines of Pennsylvania, but, outside of Pennsylvania, all the mines sell coal by the short ton. Ballast for use in concrete or macadam is generally weighed in short tons at the crushers, indeed, we believe this practice to be universal in the United States. Since it is easier to weigh than to measure broken stone, it is probable that the ton will continue to be a popular unit. For ease of calculation the short ton should be universally used, and doubtless it will be where records are kept by weight. It is important, however, in publishing records of the amount of rock used as ballast or riprap, to state the specific gravity of the stone wherever the ton is the unit used, for thus only can the volume of the solid rock be computed. Many excellent data relating to mining are of much less value than they would be were the specific gravities of the ores given. On the other hand, mining men who are accustomed to do their thinking in tons, find the cubic yard of the civil engineer an unsatisfactory unit unless the unit weight of the rock is stated. In any case, therefore, it is desirable that the specific gravity of the rock or ore be recorded.

A letter of inquiry to one of the large manufacturers of crushed stone brought out the fact that the weight per cubic foot of solid stone was not known. Probably the irregular shapes of the broken rock had made it seem impracticable to measure and weigh a fragment; and the term specific gravity, with its laboratory sound, may have operated as a deterrent to the use of a common spring balance and a pail of water. By taking a 10 or 15-lb. chunk of rock and weighing it in air and in water, the specific gravity can be approximated very closely even with a not very accurate balance, for with a heavy weight the percentage of error is small.

A clause governing the excavation of rock for a dam site has some interesting and self-contradictory features to which attention may well be called. It reads as follows:

> In this excavation the kind of explosives used, the amount of the charges, the depth and direction of the holes and the entire process of the work shall be under the control of the engineer, the object being to do the work in such a manner as to avoid fissures in the remaining rock.
>
> If at any place the contractor shall excavate, damage or shatter the solid bed rock beyond the lines given by the engineer to be excavated, and it is necessary to replace the solid rock by masonry, then the contractor shall supply such masonry free of cost to the company.

In the first sentence the engineer usurps one of the most important functions of the contractor by asserting that "the entire process will be under the control of the engineer"; and in the next sentence he seeks to escape the responsibility that morally and legally falls upon the shoulders of any one who assumes entire control of any method or process of construction. We have here an excellent example of the lax ideas that prevail as to what constitutes a free contractor and a servant. A contractor can not legally be made both. If it is desired to hold the contractor to a removal of all rock shattered beyond the neat lines, then the engineer must carefully avoid acting as a master or "boss" in directing just how the drilling and blasting shall be done. If, on the other hand, the engineer believes that he himself is a more competent blaster than any contractor is likely to be, let him manfully assume the responsibility for his own work; and he may as well assume it, for he can not legally escape it in case of a law suit.

The fact is that if the engineer does really possess an intimate knowledge of the proper methods of doing work, he usually is specific and not vague. He does not hide behind such generalities as are contained in the first sentence in the clause under discussion, but he says: "Such and such a kind of explosive shall be used, and so and so many pounds of the explosive shall be the maximum charge per foot of drill hole, and no drill hole shall extend more than so and so many inches beyond the neat lines of the excavation, and drill holes shall be spaced so and so." Such a specification shows at least that a study of the problem has been made by the engineer, and that he is prepared to stand by something definite.

On the other hand, if the engineer can not define what shall be done, for one reason or another, he had better take one of two courses: (1) Leaving the means and methods entirely to the contractor who is held strictly responsible for certain results; or (2) assuming entire charge of means and methods and specifically releasing the contractor from responsibility for results. Any attempt to follow both these courses is obviously unjust, and, what is equally to the point, will be upheld by no court.

There is no doubt whatever that the railways of the United States lead the world in the economical handling of bulk freight over long distances; but there is reason to fear that so much attention has been devoted to this field that others have been neglected. If a searching examination were made of the methods in use for handling light traffic on branch lines, it is doubtful whether American railroading would stand so high. How many railway trains are run every day which do not carry enough traffic to repay the cost of running? How many branch lines are operated as parts of large systems where no separate account of earnings and expenses is kept, and the fact that the branch is a source of steady loss instead of a source of profit, is overlooked? How many steam railway managers are facing the problem of trolley competition and yet fail to see that they will be always handicapped in such competition until they can operate single cars like the electric roads instead of trains?

As our readers are aware, we have steadily urged upon American railway managers the importance of developing the steam motor car, and have at various times summarized the progress made elsewhere in this important new departure in railroading. In this issue we again bring up to date the record of the progress made in Europe, and it will be seen that a great deal has been done toward the development and introduction of motor cars. Surely if motor cars can be used to advantage in thickly settled Europe, a much greater field exists for them on the great mileage of thin traffic railways in the United States.

It is true that motor-cars have been tried in this country, to a very limited extent, and have been abandoned; but the reason for their abandonment was that they were not designed and built with sufficient knowledge of the conditions to be met, and with sufficient mechanical engineering ability to create a design adapted to these conditions.

For example, a defect of the American cars (and from a recent editorial in "The Engineer" of London, we learn that it is a defect in the recent English cars as well), is the vibration of the car. This defect is what might have been expected as a result of mounting a reciprocating engine on a truck with no more attempt at balancing than is made on a locomotive. It ought to have been foreseen that for such service a steam motor must be perfectly balanced, so that it will not shake the car and its passengers to a disagreeable extent.

We cite this only as an example of the mechanical problems which must be met and intelligently solved, and on whose solution the success of the new departure will largely turn. We do not mean that they are problems of particularly great difficulty. On the contrary, the task of building a successful steam motor car to run upon rails is vastly simpler than the problem of building a successful motor vehicle to run upon common roads. Yet the latter has been successfully solved during the past few years, while in the United States at least the successful steam motor car is yet to be placed upon the market.

If a tenth part as much capital and mechanical ingenuity had been expended in this field as has been spent on the development of electric traction devices during the past five years, we are firmly of the opinion that the steam motor cars in service would be numbered by the thousand.

PUBLIC SAFETY AND RESTRICTIVE ORDINANCES.

The collapse of the Darlington apartment hotel in New York City, on March 2, 1904, brought before the public a considerable amount of information regarding the methods followed in planning and building light steel-skeleton city buildings. It was made quite clear in the discussion of this accident that the integrity of owners and builders can not be relied upon to protect the public from dangerous construction or improper equipment. Further light is thrown on the same subject by the discussion before the American Society of Civil Engineers of a paper by Mr. H. D. Parsons entitled "The Collapse of a Building During Construction." The discussion was printed in the society's "Proceedings" for August, 1904. The following are some brief notes from this discussion:

Mr. N. Roberts: Although there are some architects who realize the necessity of employing engineers to assist them in designing any but the simplest of steel constructions, the great majority of architects will, with the aid of a rolling-mill handbook and the free services of a contractor's "iron-man," concoct a "design" that Providence sometimes allows to be erected without accident.

Mr. F. T. Llewellyn: Protection would, of course, be best afforded by the employment of only competent engineers to cooperate with architects in the design of tall or hazardous buildings, but, as this desideratum cannot always be controlled, the building codes of our great cities should be amended so as to make impossible the flimsy structures now only too common.

Mr. J. P. Whiskeman: The designing of buildings of this class is considered in much too light a vein, and, as the operation is more or less a speculation, the temptation exists to make the structure too light at the expense of rigidity and stiffness. On account of the height being less than four times the width, no permanent wind bracing is provided and as little temporary bracing as can conveniently be put in. Reliance is placed on the curtain walls and fireproof floors to stiffen the structure, but, in reality, the framework is sometimes nearly completed before the walls are begun, therefore elements of strength are depended upon which rarely exist until the building is completed.

In tenement house construction, even more so than in the apartment hotels, the proper detailing of iron is not

more than approximated. In a corner tenement house the entire first story on two sides is left open for stores, and the walls above are supported on girders and columns, the columns resting on piers in the basement. The columns are rarely provided with shoes or caps; the girders simply rest on the columns, and are not bolted to them. Where two sets of girders meet, they are strapped together with a narrow plate placed across the joint diagonally and bolted somewhere on each side with one bolt, usually the separator-bolt. This joint could open 1 in. without even straining the strap. No attempt is made to tie or anchor the columns, and, when a pier settles, on account of the lack of rigidity, the building partly or wholly collapses. In one case, a narrow column, supporting a front and not provided with a bottom flange or shoe, on account of the concentrated load in the center of a poorly-bedded pier cap, cracked the cap and the front collapsed. In another instance, practically the whole of a six-story tenement house in process of completion collapsed by the undermining of a single pier. There is practically no engineering at all in tenement house construction.

The design for the framing of apartment hotel buildings is a problem for treatment by a competent structural engineer, but is more often solved by the use of tables which are but poorly understood and applied accordingly. In some cases the engineer or architect who knows better will prostitute good design to cheapen the cost.

This is one-half the solution of the problem; the solution of the other half is the employment of a competent superintendent on the premises to see that the work is executed properly and that no undue strains come upon the uncompleted structure.

Mr. C. C. Schneider: A competent and reputable engineer needs neither building law nor supervision; however, as we cannot compel owners of buildings to employ competent engineers, it becomes necessary to have proper and strict supervision over all structures of this kind. The people generally rely on the building departments for protection against unscrupulous contractors and ignorant pretenders. Therefore, the building department of every municipality should employ a sufficient number of competent engineers to enable them to examine the designs properly and carefully and inspect the work of all structures within its jurisdiction. This supervision should be not perfunctory, but thorough. If a design is not safe it should be rejected, even if it conforms to the letter of the building law.

It should be the duty of the building department (and that department should have the power) to see that all structures are safe, first, last and all the time, with or without building laws.

Mr. Oscar Lowinson: The problems connected with apartment hotel construction in New York city are somewhat different from those in commercial buildings. In the first place, the buildings being purely speculative, the designers have been compelled to exercise every device possible to enable them to secure the completion of the buildings at a minimum of cost; and, as the buildings must be sold as soon as possible, there are no responsibilities other than moral, and as long as the building stands together until sold, the only controlling influences are the conscience of the owner and the restriction of the public authorities.

Our laws are fairly good. It is a very difficult matter to frame laws so as to cover every detail of construction. This building has made manifest . . . the crime of constructing buildings with no intelligent supervision. The idea that a public department should assure the safety of the construction is also wrong. The main weakness in the law is that there are no means of compelling the class of people who are building now to employ competent men to undertake this construction.

Mr. George A. Just: At the very beginning a clear distinction should be made between the law, on the one hand, and the administration and interpretation of the law on the other. The most perfect law, when administered or interpreted by incompetent or corrupt authority, proves ineffectual and often oppressive. But building laws, like all other civil laws, even when honestly administered, need intelligent interpretation and consequent modification from time to time, and it is remarkable that, while other branches of law are interpreted and modified by lawyers through the machinery of the courts, public sentiment does not demand that its laws relating to construction be interpreted by engineers, who, it must be admitted, alone are capable of directing the proper application of what is, after all, *natural* law, as against the law of accumulated precedent. This inconsistency, however, can be traced to an apparent, if not a real, lack of interest in public affairs by engineers in the past. They consequently lack weight when new thought is molded, even when it relates to matters so distinctly within the engineering field as the formation or amendment of a "building law."

The fact cannot be overlooked that a "building law" must necessarily be perfectly general in its application; that all its provisions cannot possibly be made so comprehensive as to apply to each specific case, and that any attempt to do so must result in a limitation of individual rights, on the one hand, or endanger public safety on the other. And so it may be said that the best criticism made of the New York code, under which the collapsed structure had been partially erected, is that it "pretends too much engineering." The chance of repetition of a "Darlington" disaster would be materially reduced if much of the present detail matter were eliminated, thus making the provisions of the code more general. The unprincipled practitioner would then not be able, as now, to force a department of a municipal government to act practically as engineer in the design of work for which he himself is incompetent. It might terminate the practice of designing "according to law," and kill the assumption that individual structural members, when of proper section for the performance of their intended functions, will make a safe structure, irrespective of the manner of their assemblage or the quality of the general design. The result should be that experienced professional talent would be engaged more generally.

The present law is weak, in so far as it lacks requirements for proper superintendence, and the "regulations" of the department on this point are no better. This could be remedied by an amendment requiring that: No building shall hereafter be erected without the continuous direction and superintendence of an architect, or civil engineer, who shall have had at least five years' experience in building construction; no work shall be commenced until the name and address of such superintendent is filed with the Bureau of Buildings, and all changes of superintendent during construction shall be similarly certified to said bureau.

The influence of the American Institute of Architects could be very properly exerted for the enactment of such a section. It would tend to break up the present pernicious practice of architects engaged on speculative work, who accept commissions for the making and filing of plans, leaving the execution of the work to incompetent or unscrupulous persons. Too often this early termination of relations between architect and client is only apparent, and at times results in deceiving the public authorities. Proof of such continued relationship, however, is shown when these architects, as is often the case, permit themselves to be used to harass the contractors for the benefit of their speculative employers.

These opinions primarily emphasize the fact stated in our introductory paragraph. As Mr. Schneider puts it, since "we cannot compel owners of buildings to employ competent engineers," and since experience shows that in many classes of construction the owners and builders care for nothing but to keep within the letter of the law, or if possible to evade the law and avoid detection, then "it becomes necessary to have proper and strict supervision over all structures of this kind." The question then arises: how is the proper supervision to be secured?

This question and its subsidiary problems are met in other fields of work besides merely that of speculative building construction. In the matter of elevators, which has aroused much attention recently, the same thing is encountered. In a letter to the New York "Telegram" of September 26, an elevator inspector says:

> There are hundreds of elevators in this city in passenger service which are not equipped with any adequate safety devices, and many which have no safety appliances whatever. The freight elevators, which are used to carry thousands of people during rush hours and repairs on the passenger cars, etc., are generally found in even worse condition. The sole obstacle which lies in the way of making elevators safe consists in compelling owners to spend a few dollars for the necessary appliances. Mechanics have solved the problem in a great variety of ways, and so successfully that an elevator may be made at least as safe as a street car to ride in. As a rule, though, proper and adequate safeties are an item of extra expense in building an elevator, hence their omission.
>
> The statement that the majority of accidents are due to the carelessness of operators, or those in charge of the machinery, is erroneous. It is true that lack of attention to the machinery often results in derangements that lead to accidents, but they are oftener due to faulty construction or design which should never have been permitted. In most cases the control of the mechanism is placed entirely beyond the reach of the operator in all respects except the mere starting and stopping the car, and this is proper.
>
> Insurance inspectors can do nothing, because the only penalty they can inflict is to cancel the insurance or refuse the risk, when some other inspector will usually be found who will accept it. What the public should understand is that the great majority of elevator accidents are due to criminal negligence, and that the responsibility rests with the owner or with the elevator builder who persuaded him to believe that a machine was safe when he knew it was not—and the builders know.

The writer of this letter seems to imply that by bringing sufficient moral pressure to bear on owners and elevator-builders, the problem of ensuring the use of safe elevators only will be solved. But if we were inclined to put as much trust in the honesty of human nature as this implies, the experience in the closely analogous field of apartment-house construction would be sufficient to destroy this trust. In a recent article in our columns* on the subject of elevators, Mr. Edward Van Winkle throws the responsibility for present insecure conditions on the public authorities—the Building Department, and presumably also the law.

When we proceed from this point, two facts must be recognized. The first is that a law must be general, and should not attempt to be too specific; the law may not presume to act as consulting engineer, nor can it ever, with safety, attempt to codify and prescribe for all the various and varying natural conditions which are daily met with in construction. This point has already been maintained by us, in the discussion immediately following the Darlington accident. Without further attempting to establish it by argument, we refer to the words of Mr. Just, above quoted, which convincingly express the same view. Mr. Schneider also implies this, in his words: "If a design is not safe it should be rejected *even if it conforms to the letter of the building law.*"

Here we come face to face with the second fact above referred to. The trend of judicial decisions in American courts is clearly toward the position that when an ordinance such as a building law specifies definite requirements, then it must be interpreted literally, and rejection on grounds of public safety is denied. Recently, when plans were made to remodel the Iroquois Theater in Chicago (where the horrible fire-catastrophe of last December took place) in conformity with the city's new theater odinance, the Building Department refused a building permit on the ground that, while the revised designs might be construed to be in accordance with the law, yet they did not offer adequate safety. When the matter was carried into court, the city was beaten, and the permit issued by mandatory proceedings. At present the theater is again in operation. But court decisions seem to go even farther than this: they appear to oppose the principle of general provisions in the case for example of building regulations, and to hold that specific requirements should be made if the power of the courts is to be used for enforcing the law. Certain it is that the difficulties of attempting to enforce general provisions in the courts are very great. Suppose the original designs for the Iroquois Theater as originally built, or the contract plans for the Darlington Building, had been offered for approval under a general law requiring the approval of a competent expert employed by the building department. If, under these circumstances, the expert had rejected the plans because of the features that actually resulted in the two disasters, and if the builders had carried the matter into the courts, it is certain that the building department's case would have been hopeless. Conservative engineering opinion has little chance against "expert testimony" in a court of law.

A solution for the dilemma may be found in using an intermediate between specific and general laws in a manner like that of the new elevator ordinance proposed for New York City, as noted in these columns in our issue of Sept. 22, 1904. That ordinance delegates to the department the power of making regulations and certain specific enforcing powers, but it does not itself establish the regulations. It is a general law in the meaning heretofore used; it is specific in throwing the burden of ensuring safe elevator construction upon the department, and at the same time it is general in that it does not "pretend to too much engineering" and does not need frequent revision to keep up with changes in conditions and developments in the art. The specific requirements are to be established by the department, and may be revised without trouble as often as conditions make it necessary.

Another solution is to require, by means a law otherwise general, that the work in question—be it steel-frame building design, or elevator construction, or any work similarly involving the public safety—must be done by a person of recognized competence and stated experience, whose professional standing will then be a guarantee of

*"Some Recent Elevator Accidents," by Edward Van Winkle; Eng. News, Aug. 25, 1904.

proper construction. This plan, though it does not bar out abuses, may be made to work fairly well, especially if combined with the previously-noted plan of having specific regulations established by the proper public authority under a suitable general empowering law. But it approaches in a measure the "engineers' license law" plan, which is not looked on with favor by many (or most) American engineers.

The solution first noted, however, is sufficient in itself, and if conscientiously handled, that is without gross incompetence or dishonesty in the public department concerned, should secure satisfactory results. It is probably the only way in which a department charged with ensuring public safety or convenience in a given field can attain this end efficiently. If the revised New York elevator ordinance is adopted, its working will offer interesting testimony on this point. The possibility of political abuse seems the only serious menace to the efficiency of the method.

LETTERS TO THE EDITOR.

Influence of the Earth's Rotation on Rail Wear.

Sir: In your issue of September 15, page 128, you report on a paper by Mr. S. T. Wagner on the creeping of rails read before the recent meeting of the American Society of Civil Engineers. In this paper you extract the following conclusion: "the right-hand rail showed only very slight indications of creeping more than the left, although all engines on the line have the right crank leading."

It has long been a matter of curiosity to me whether any such excess of action on the right-hand rail actually took place as theoretically it should, owing to the motion of the earth. It is known that any body moving over the earth's surface experiences a deflective force at right angles to its path of motion proportional to the sine of the latitude, this deflective force being to the right in the northern and to the left in the southern hemisphere. The equation for this force is

$$F = 2\,n\,s\,\frac{W}{g}\sin\theta$$

in which n is the earth's angular velocity of rotation, s the velocity of the moving body, W its weight and θ the latitude.

Taking for example a railroad train weighing 600 tons running on a straight track at forty miles an hour at the latitude of 45° N, we have

$$\frac{2n}{g} = .00000065,\ s = 40,\ W = 600 \times 2000,\ \theta = 45°$$ and

$$F = 6.65 \times 40 \times 600 \times 2000 \times .707 \times 10^{-6} = 226 \text{ lbs.}$$

which represents the lateral pressure on the rail.

If the axis of gravity (i. e. a line passing through the c. g. parallel with the track) of the train is 4 ft. above the rail, the excess of vertical pressure on the right-hand rail would be

$$226 \times \frac{4}{4.71} = 190 \text{ lbs.}$$

An excess of pressure of 200 lbs. in 600,000 (the weight on one rail), or one part in 3,000, is certainly very small, yet might be sufficient to produce the actual excess of creeping noted. This would be proved by noting a similar creeping in the southern hemisphere in which the excess was with the left-hand rail.

On a single-track line the rails should creep in opposite directions.

I do not know that the effect of earth-motion on railway practice has been practically considered; if so, would be pleased to know of the fact and whether any like effects have been previously noted. George W. Colles.

Milwaukee, Wis., September 23, 1904.

The Cause and Prevention of Sewer Gas Explosions.

Sir: In your editorial note, following my letter in your issue of Sept. 22, you stated that you did not publish the sketch of the manhole covers, as perforated manhole covers are very common in this country. Unfortunately, I did not mention that the new manhole cover gives a very good foot-hold for people and horses, which is not the case with the form now generally used.

You state that the general cause of the explosions is by leaky gas mains. The chemical and physical compositions of illuminating gas and the explosive part of the sewer gas are almost the same, both being lighter than the atmosphere. Naturally both gases seek their way up. In cities where the ventilators in question are used, there has never occurred any sewer gas explosion. For very large sewers I should increase the capacity by connecting the ventilators and leading the connecting pipe to an electric fan.

Concerning ventilating by the house sewers, you misunderstood me. It is, as you stated, a bad design to use the private house sewers for ventilating purposes. In sewers so constructed, the slop water running fast, draws in air which is left in the main sewer, thus decreasing the capacity of the main sewer, besides causing inconveniences for the houses. I meant ventilating pipes, altogether separate from the private sewers. They are similar to the ventilators; the only difference being that instead of ending at the street surface they go up to about 3 ft. above the roofs. Very respectfully,

C. H. Liedbeck.

4748 Calumet Ave., Chicago, Sept. 23, 1904.

(That there is no specific sewer gas, we did not think it necessary to point out in the note appended to Mr. Liedbeck's letter in our issue of Sept. 22. In the title, however, we used the words "so-called sewer gas explosions," thus indicating the air in a well-constructed sewer, with good grades, good flushing and good ventilation, does not differ greatly from that in the streets above. The poorer the construction, grades, flushing and ventilation, the greater will be the quantity of gases of decomposition in the sewer. Adjacent leaky gas mains will add their quota of illuminating gas. We do not deny that there may be instances where the gases of decomposition have been of such a character and volume as to give rise to explosions and many more instances where only a spark was needed to cause an explosion. But we continue to believe that most so-called sewer gas explosions are really explosions of illuminating gas.

Whatever the cause of these explosions, means for their prevention should be adopted. In so far as they are due to leaky gas mains, no one should rest content with providing sewer ventilation, for: (1) It is questionable whether sewer ventilation at its best, as thus far developed, would be an absolute safeguard against explosions of illuminating gas in sewers, and (2) leaky gas mains give rise to other dangers than those incident to explosions in sewers. For these and other reasons, a crusade should be made against leaky gas mains.

We did not state that it is "a bad design to use the private house-sewers for ventilating purposes." We said that "is a mooted question, but it is on the side of economy," etc. We also remarked that the "proposition would horrify many British sanitarians." We think there is much to be said in favor of ventilating street sewers through house sewers and soil pipes, and that such a system of ventilation, combined with perforated manhole covers, would probably be much more efficient than ventilating shafts, with outlets at the street level.—Ed.)

The Value of Bidding Prices as a Guide in Cost Estimating.

Sir: In an editorial in your issue of Aug. 25 you seem to disparage the habit of consulting the files of engineering journals in order to obtain a basis upon which to estimate the cost of work. What is the inference to be taken from this? Are these records unreliable, and what is the method you would recommend? You leave the reader in doubt on this point.

In a discussion with a fellow engineer on this subject, he attempted to show that the ability to estimate the cost of work can only be obtained by experience, and that published data on the subject are of little value. This savors of the time-worn contention of the "practical man" against the book knowledge of the technical man; but nevertheless engineering has made greater progress in fifty years of the application of technical knowledge than it made in as many generations of exclusively "practical" methods. It savors of the days when men held bound up in a napkin their talents in the shape of secret formulas, which were only allowed to eke out to the "bound boy" or apprentice in small driblets.

I do not wish to be understood as attacking the position taken in your editorial, but merely using it as a text, my aim is to show that a piece of the shell of old time methods still clings to engineering, though it has been out of the nest for more than a generation.

Why should a knowledge of the cost of proposed work be any more difficult to obtain through a study of the subject than a knowledge of how to design the work? Of course experience is excellent in either line, but it falls to the lot of a very few to have experience in some lines of work. Great suspension bridges, for example, are rare, and the number of men who have designed those already built is small. Are all other engineers to be classed as incompetent for the task because they have had no experience in that line?

Again, it is not rare to find men who have had long years of experience repeating the same errors or using the same antiquated methods; whereas one younger in the profession is often conversant with later and more improved practice—all because of the free intercourse that obtains in all but the realm of cost.

Assuming that one has had experience in the matter of contracting for work, handling men, etc., is that experience, which probably is local and under limited conditions, of more value than the experience represented by the current prices for which work is being let by contract, covering, as the latter does, so large a field? On the basis of his experience, a man might estimate the cost of steel work, for example, on the price of raw material, the handling of the same, punching, riveting, freight, painting, etc., and arrive at a certain price for the job. Another, not having this experience would take a price per pound based on the contract price for similar work. The former would be in the case of a consumer who, if he wished to, buy 100 bushels of potatoes, would estimate the price of seed potatoes, the cost of plowing, hoeing, marketing, etc., and from the probable yield per acre would arrive at a price per bushel. The latter is in the case of one who consults the market report, and learns immediately, not what it costs a particular farmer to produce potatoes, but what the great aggregate of farmers and middlemen will let the article they own be sold to the public for. One shop can turn out light work to greater advantage than another, because the shop is suited to the handling and working of such work. Heavy work, which may be turned out at a profit by another shop, at a certain price, may at the same price be produced at a loss to the shop fitted to handle light material. So one farmer may have to sell his potatoes at a loss to forestall their rotting. His experience in raising potatoes is more valuable to himself than to the public; but it is not the average experience, or prices would be adjusted to suit the condition.

Another way to make an estimate is illustrated by a court case with which I am familiar. Two engineers made careful estimates of the exact amounts of steel, wood, etc., in a structure, and basing their calculations upon unit prices of similar work arrived at practically the same result as a fair price for the completed structure. Two other engineers simply view the structure and testified that it was cheap at just double the price obtained by the others as a result of their careful calculation. The basis of the estimate made by these second engineers was their "wide experience"; and the learned judge declared that good evidence had been brought to show that the structure was worth the higher figure! Is this the correct method of making cost estimates? As one would judge the price of a horse or dog. To use the figure of the potatoes again: Would a farmer who had handled potatoes all his life, be better able to judge the value of a great heap of potatoes by viewing it than a mathematician, who did not know a potato bug from a wasp, but who had measured carefully the volume of the heap and estimated the value by the market price of potatoes?

It is true that published contract prices need intelligent interpretation, and that the conditions and specifications often affect the unit price considerably. Also, prices vary from time to time. All of this emphasizes the need of a book on the subject of systematic price estimating.

It would be a good thing to lift the matter of estimating cost out of the uncertain hands of judgment and place it in the more stable hands of scientific rule. Judgment and practice and experience are good things to have; but what purpose does instruction serve, if it is not to make these available to others besides their first possessors?

"Waskostet."

Pittsburg, Pa., Sept. 7, 1904.

(That we believe in the value of published bidding prices is indicated by the fact that we publish them. On the editorial page of our Construction News Department for Aug. 27, 1903, was given a brief discussion of the use and abuse of such data. One of the dangers arising from the use of "average bidding prices" is that they will be applied to conditions that are not "average," and this happens more frequently than is commonly supposed. Our criticism of the common practice of using previous bidding prices as the basis of cost estimates is intended to apply to the use of such prices as the sole source of information. This tendency to rely on "average contract prices" perhaps accounts more than anything else for the dearth of actual cost data in print. The engineer who has formed the habit of relying upon contract prices (="market quotations") will seldom make serious errors in estimating the cost of structures in which the cost of materials forms the greatest part of the total cost; but he will err seriously when he comes to estimating the cost of structures in which the labor item is predominant, or in which the outlay for plant and "development expense" forms a considerable part of the whole cost.

We agree with our correspondent in believing that actual cost data possess a value too often under estimated.—Ed.)

The International Engineering Congress at St. Louis.

(Continued from page 332.)

ditches. Probably not less than $200,000,000 has been expended in irrigation works and the resultant values represent many times that sum. The water rights in Colorado are estimated to be worth $90,000,000.

Besides Mr. Mead's paper, Mr. M. M. O'Shaughnessy of San Francisco, contributed a paper describing the irrigation work in the Hawaiian Islands by which an annual crop of sugar valued at $14,000,000 is produced; irrigation in France was described by M. Paul Salvador of the French Department of Agriculture and irrigation in Java, was described by J. de Meyier, late Director of Public Works in Netherlands, India. The last-named paper was a particularly important one covering some 50 pages, besides maps and illustrations.

On Wednesday the Section took up the subject of highway construction which was opened by Mr. James Owen, of Newark, N. J., with a paper in which present practice in the United States in this class of work was summarized. One point which was made much of in Mr. Owen's paper may be mentioned here. It is that the methods of road construction will vary largely with climatic conditions and what is best practice at one place may be anything but the best for another place where very different climatic conditions exist.

Besides Mr. Owen's paper, a contribution was presented from Mr. Wm. E. McClintock, Chairman of the Massachusetts Highway Commission, and another from Mr. G. Forestier, of France. Written discussions of Mr. Owen's paper were contributed by Messrs. R. J. Thomas, of Buckinghamshire, Kent, England, and Halbert P. Gillette, of New York City. Mr. Thomas gave some interesting experience with the maintenance of roads subjected to heavy automobile traffic. It is found that the suction of pneumatic tires pulls out stones and dust and breaks up the surface of the road in a manner not heretofore experienced. He had found that the very firmest and smoothest surface on macadam was necessary to prevent its going to pieces under such circumstances. He had tried painting the macadam surface with tar with good results.

Among those who took part in the oral discussion were Messrs. Henry Manley and W. R. Hillyer. The latter described his successful use of a 4-tooth scarifier with great economy in resurfacing roads on Staten Island.

Following this subject came a paper on deep foundations by W. F. Druyvesteyn of Holland, describing the sinking of some brick cylinder piers by interior dredging to a depth of 42 ft. below water level or a foundation for a quay wall. Papers on the operation of mines in France by E. Gruner and on American practice in mining engineering by Mr. E. G. Spilsbury were also presented.

At Thursday's session the first subject called up was engineering education, a paper by Prof. Robert Fletcher of Hanover, N. H., being presented by Mrs. C. M. Woodward, Dean of the Engineering School of Washington University, who was himself down on the program for a paper.

The final topic considered by this section was surveying, which was treated in two very interesting papers, one prepared by officers of the U. S. Geological Survey, the other by the U. S. Coast and Geodetic Survey. Each of these papers set forth the current methods of work in use in these respective departments and described the important changes which have been made in recent years. In the discussion some of these methods were criticised.

Final General Session.

On Saturday morning, Oct. 8, the final session of the Congress was held, all the sections meeting together. The President of the Congress, Mr. Charles Hermony, again acted as Chairman, and reports were presented by the chairman of each of the several sections describing the work done in each. Mr. Chas. Warren Hunt, Secretary of the Congress, then presented a summary of the work done. There had been held 28 different sectional meetings, at which 97 formal papers were presented, besides 78 written communications in discussion of these papers. The number of oral discussions amounted to 272. It has been decided that further written discussions of these papers will be received from engineers in the United States up to Dec. 1 and from engineers in foreign countries up to Jan. 1. The entire proceedings of the Congress when finally printed will comprise probably over 3,500 pages. The total membership in the congress is between 3,400 and 3,500; a small percentage only of the membership was in attendance at the meeting. The total registered at the Congress, which included in many instances the families of members accompanying them was 861. Of this number, 727 were from North America, 10 from South America, 110 from Europe (of whom 70 were from England) 10 from Asia and 4 from Australasia.

The proceedings of the Congress were then concluded with brief addresses of felicitation and farewell by members of the foreign delegation including Sir William White of Great Britain; Karl P. Dohlstrom of Sweden; Francois Schule of Zurich; O. F. Schosberger, of Vienna; B. Bachtamen, of St. Petersburg; the Secretary-General of the Royal Institution of Engineers of Holland and T. Shinin, Engineer of the Government Railroads of Japan.

THE VALUE OF COPPER SULPHATE as a protection from typhoid fever germs in public water supplies has not yet been officially vouched for by Dr. Geo. T. Moore, of the U. S. Department of Agriculture, editorial and other statements in the daily press notwithstanding.

A BRITISH TORPEDO BOAT DESTROYER WAS lost on Sept. 26, 1904, by a peculiar accident. While the vessel, the "Chamois," was going at full speed one of the blades of the propeller came off and pierced the shell of the vessel, sinking the boat. The crew was saved.

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400 TONS OF DYNAMITE EXPLODED near Dover, N. J., Oct. 4. The dynamite was in the packing house of the American Forcite Co., at Lake Hopatcong. The packing house was a light frame building, 125 × 50, one story high. No life was lost as the explosion occurred at night time. It is believed that the gnawing of rats may have caused the explosion.

GAS IN A RAILWAY TUNNEL ASPHYXIATED six employees of the Grand Trunk Railway, Oct. 9. The accident occurred in the St. Clair Tunnel under the St. Clair River between Port Huron, Mich., and Sarnia, Ontario. A train of 17 coal cars broke in two in the tunnel, and the engineer, with three cars attached to the locomotive, steamed out into the Sarnia yards where he uncoupled. He returned to the tunnel and attempted to push the 14 cars back and out of the American portal, but the grade was too steep. The engineer was suffocated by the coal gas, as were four men on the stalled cars. A. S. Begg, Superintendent of Terminals, lost his life in attempting to rescue the men in the tunnel.

A DISASTROUS RAILWAY ACCIDENT occurred on the Missouri Pacific Ry. near Warrensburg, Mo., on Oct. 10, 1904. The second section of an eastbound passenger train, carrying a World's Fair crowd, collided head-on with a westbound freight train. The collision happened in a sag, where both trains ran at a high speed, and resulted in totally crushing the first car of the passenger train. Twenty-eight persons were killed outright, and many others badly injured. The passenger train had been split into two sections some distance back of the point of the accident, a locomotive being attached to the rear half. The freight train waited for the passenger in a siding at Montserrat, Mo., some three miles east of the place of the collision. The first section, carrying signals that a second section was to follow, was followed by a local train, which the freight crew took to be the second section. It pulled out and collided with the second section when three miles out.

RUBBER PAVING IN LONDON is the subject of a recent consular report. The paving is used in two roadways passing under the hotel of the Euston terminal station of the London & Northwestern Ry. This was laid in 1881 at a cost of $5.60 per sq. yd. for concrete foundation and $27.10 per sq. yd. for the rubber paving, 2 ins. thick. In 1902 the thickness had been reduced by wear to ⅝-in. in some places and 1 to 1¼ ins. at others. Bids for new rubber paving in that year were from $27.09 to $86.22 per sq. yd., the lowest bid (India Rubber, Gutta Percha & Telegraph Works Co.) being accepted. The total cost of the work, including laying, and deducting credit for the old rubber, was $28.75 per sq. yd. The material is not pure rubber, and is vulcanized. It was used in 1895 in Wellington Court, London, where it gave excellent results. The new courtyard of the Savoy Hotel, London, 75 × 50 ft., has been paved with rubber by James Stewart & Co., at a cost of $40.86 per sq. yd. The area paved is 2,195 sq. ft., with a concrete foundation and 2 ins. of rubber weighing 15¼ lbs. per sq. ft. The purpose of this expensive but durable paving is to make the paving absolutely noiseless.

PLANS FOR A 20,000-TON BATTLESHIP are being prepared by the U. S. Navy Department—according to Washington news reports. It is stated that while the tonnage is enormous, the most radical departure from previous practice is that of armament. Instead of having a main battery of four heavy guns backed by a secondary battery ranging from 6-in. guns to one-pounders, the main battery of the new ship is to consist of ten 12-in. guns, placed in turrets and broadsides, with a secondary battery made up entirely of at least twenty 3-in. quick-firing guns. The speed of this battleship will probably not exceed 16 knots; but following the successful practice laid down by the Japanese navy, she would be equipped with the heaviest long-range battery afloat; while the great number of quick-firing 3-in. guns would form the best defense possible against torpedo attacks.

FORESTRY AND TREE-PLANTING are the subjects of three outdoor exhibits made at the St. Louis Exhibition by the U. S. Department of Agriculture (Bureau of Forestry). A demonstration forest nursery of 8,100 sq. ft. is devoted to coniferous and broad-leaf trees. The coniferous seed beds show various methods of seeding and different kinds of screens for securing suitable shade. The broad-leaf species are planted in beds and rows. A model farm of 264 ft. square shows the use of forest trees for windbreaks, hedges and woodlots in the prairie states. It is on a scale of one-tenth the natural size of a quarter section, and shows the arrangement of fields, farmstead and forest plantations on a prairie farm of 160 acres. The third exhibit is to illustrate different methods of forest planting in woodlots, and consists of plots 24 ft. square planted with different species and mixtures suitable for different parts of the United States. Woodlot plantations are made for the production of fuel and timber rather than for protection from wind.

THE DRAINAGE AND SEWERAGE OF NEW ORleans is reported upon by Mr. George G. Earl, M. Am. Soc. C. E. and Engineer of the Sewerage, Water and Drainage Board of that city. The details of this operation have already been set forth in this journal, consequently a statement of the progress made to this date is sufficient. The area included in the improvement amounts to about 36 sq. miles; an area entirely protected by levees, with extreme high water in the Mississippi 6 ft. above the highest point inside this area and 20 ft. above the lowest point. This 36 sq. miles, when fully developed, will contain 1,000 miles of streets, while the present well built or rapidly building section covers about 14 sq. miles, with 375 miles of streets with a resident population of 315,000. The drainage plan of 1895 contemplated 100 miles of drainage arteries, or 20 miles of high-level outfalls and 80 miles of low-level canals. The original estimate of $8,000,000 covered the construction of 34 miles of canals in the built-up areas, with the necessary pumping plant. Of this sum about $4,500,000 has been expended on 17 miles of the canal and about one-half of the pumping plant now required to deal with the very occasional heavy storms. With $700,000 more lately appropriated it is intended to improve the main drainage situation, but the city is growing rapidly and an amount greater than the unexpended balance of $3,500,000 will be required to bring the main drainage system to a point which will give to all well built sections the opportunity for the local improvement proposed. The effect of the money already expended has been the equivalent of raising the whole city 10 ft. higher than it was, and this result fully warrants the further expenditure demanded.

The main sewerage and the sewerage pumping contracts were awarded in June, 1903, and seven more pipe sewer contracts and contracts for the building of the pumping stations were let in 1904. All of this work is to be completed in 1905, at an aggregate cost of $2,600,000. The contracts cover 16 miles of main sewers and force mains, 111 miles of pipe sewers, and 9 pumping stations. At present about 85 miles of the total 127 miles are completed. In the next four years about 250 miles of pipe sewers will have to be contracted for and laid. So far the difficulty of constructing these sewers is less than was expected.

Practically no start has yet been made upon new waterworks construction, though 65 acres of land have been secured for a water purification and pumping site. Letting has been delayed by the very high price of pumping machinery and pipe, but this cost is now about 30% less than two years ago, and the Water Board has authorized the advertising for contracts for about one-fifth of the total water pipe needed (8,000 to 10,000 tons of cast-iron pipe) and the complete pumping machinery and equipment. Bids for laying this pipe will be received early in 1905.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, October 13, 1904.

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The publication of a new technical book, especially if it be a good one, is so interesting an event to the engineer that the fact may properly be classed and treated as news. Technical books are such useful tools and become out-of-date so rapidly that an engineer wishes early notification of their publication and also an early estimate of their value. If the book be good, he wishes to secure it at once; if it be mediocre or bad, or however good if it be no improvement on others previously in existence, he wishes to be informed of the fact and thus saved a needless expenditure of money. In accordance with the foregoing views an attempt has been made during the nearly two years since this Supplement was started to review every book received as promptly as possible. Now and then a book comes in so nearly the time of going to press that it is impossible to secure an adequate review of it until the following month, particularly when it is considered desirable to send the book to an outside reviewer.

The last number of this Supplement contained less matter than any preceding it. That was due to a combination of such causes as the dulness of late summer among publishers, the promptness with which reviews of books had been published during the preceding months and the occasional delays incident to sending books away for review. The present number of the Supplement marks the opening of the publishing season of 1904-5, which, judging from the number of notable books reviewed in this number and announced for early publication, promises to supply book buyers with much important matter for consideration.

To what extent should a writer on engineering subjects cultivate literary style? For the present no attempt will be made to answer this question directly, but two quotations from an eminent literary critic will be submitted for the consideration of our readers. In his introduction to "Early Victorian Writers," Frederic Harrison used these words:

> . . . the flat, ungainly, nerveless style of mere scientific research. What lumps of raw fact are flung at our heads! What innumerable gritty collops of learning we have to munch!

And again he says:

> Huxley and Tyndall have given their brethren in science fine examples of a pure, vigorous, and well-knit style. Yet, how many of them are still quite content to go rumbling along with an interminable rigmarole of dry "memoirs."

These words were written ten years ago, and were not designed to apply to engineers, yet they are largely true to-day and are probably quite as applicable to engineers as to what Mr. Harrison calls "scientists," except that engineers as a rule are too busy to write "interminable memoirs." What they and lecturers on technical subjects are liable to do is "tumble" their "note-books into a volume all in a heap," as Mr. Harrison says is the tendency in all recent literature. It would be interesting indeed to see a list of engineering writers who have a notably good literary style. Such a list would perhaps help to answer our opening question, since it might throw some light upon the relation between a good literary style and success in the engineering profession, and therefore upon the desirability of a good literary style for engineering writers.

The recent announcement of a paper before the Engineers' Club of Philadelphia on "Washington as an Engineer," in connection with some facts given in the volume in the Historic Highway series, reviewed elsewhere in this issue, suggests the thought that an interesting study might be made of Franklin as an Engineer. In a letter sent from London in response to an inquiry from America regarding canals, Franklin made some suggestions which, if followed, would have saved the various States of the Union, and also the private promoters of internal improvements, millions of dollars in the first fifty or sixty years of this country. Whether Franklin's ideas, which are stated in the review already named, ever came to the eye or ear of Washington, we cannot say. Probably they never did; at least not directly. But had Washington heard and heeded Franklin's suggestion as to employing an engineer from England to come to America and assist in improvements to navigation and his further remarks on the risks attendant upon the canalization of streams subject to freshets, the first President of the United States and of the Potomac Co. would have saved himself and his associates in plans for providing through navigation to the Ohio River from the failure in which their enterprise resulted. In a large sense, both Washington and Franklin did attempt something and suggest far more in the way of directing the forces of nature in the service of man. That Franklin achieved or aided in the achievement of far more than did Washington, can not rob the latter of the high esteem in which he is held, not only by his own country, but also by the whole civilized world of to-day.

Progress in securing uniform water-works statistics is slow but gratifying. Some twenty years ago a statistical form was adopted by the New England Water-Works Association, and recently that form was amended to meet changed conditions. The form has been used by a varying number of water-works officials in presenting statistics for their works in their annual reports, and from time to time those statistics have been combined in tabular form and published in the Journal of the New England Water-Works Association. Recently the tabulations have appeared yearly. The Journal for September contains "more or less complete statistics" for the year 1903 for no less than 48 water-works. Most of these works are in the New England States, but a few are located in New Brunswick, New York, New Jersey, Pennsylvania, Ohio, Wisconsin, and Minnesota. Cities as large as Boston, Providence, Rochester, Cleveland and Minneapolis are included in the tabulation for the year 1903. Unfortunately the statistics for a number of cities are far from complete, but it is encouraging to have even partial recognition of this commendable attempt to secure comparative statistics. For the benefit of those who have not seen the schedule under discussion, it may be said that it provides for ownership of works, source and mode of supply, and statistics of pumping, finances, distribution and consumption. While to many it may seem discouraging that only 48 works are using the form, and some of them only in small part, twenty years after its adoption, yet to those who have tried to secure uniform municipal statistics of any kind even such results are gratifying. At one time or another 78 different cities have used the form, and the figures thus compiled have been brought together, as already stated, in various numbers of the Journal. A more general adoption of the form in the future may be expected.

A special library which should interest quite a large range of men is being started just at present. It is to be a library of municipal engineering—a field which is not well represented in most existing book-collections. The Municipal Engineers of the City of New York, a society* formed about a year ago among the engineering employees of the city, has begun active work in collecting such a library for the benefit of its members and for general reference. The society at present has rooms at 142 West 49th St., New York, but will become a tenant of the Union Engineering Building when that is completed; its library will then be housed in the same building with some of the best libraries of America in other fields of engineering.

The plans entertained for this library are in many respects novel. It is proposed to gather and place on file all information of permanent value relating, first of all, to the engineering work of New York City, and also similar matter relating to other cities and municipal enterprises in this country and abroad. Files of specifications, reports, contract drawings, standards, forms and permits, construction photographs, etc., are contemplated, beside the collection of books on municipal engineering work and trade catalogues of the supply industries. If these plans are carried into effect even in part the library will furnish a most valuable study-ground for not only the members of the society, nor even only municipal engineers, but also for constructing engineers of many classes.

The work of building up this library begins under very favorable conditions. The society already includes the chief engineers and the principal assistant engineers of all the city departments, so that the hearty co-operation of these departments may be expected. It is hoped also that engineers throughout the United States and elsewhere will become interested in this library and will contribute to its enlargement.

In most branches of engineering there are numerous books on construction, but few or none on the operation of the works constructed. To mention only one branch, there are many books, both American and British, on designing and building water-works but none on maintenance and operation. This lack, and it is a serious one, seems all the more remarkable when it is remembered that water-works is one of the earliest and most numerous classes of municipal works. In the United States alone there are to-day some five thousand water-works, each with one and many with two to ten or more administrative officers. A man new to one of these positions, or with some new problem to solve, or wishing to improve on old and perhaps utterly inefficient methods of operation, has absolutely no book to which he can turn for information. If he has access to the publications of the water-works associations he will find more or less to help him. His search will be made easier now that an index to the "Journal of New England Water-Works Association" to the close of 1903 has been published and would be made easier still if an index were provided for the Proceedings of the American Water-Works Association. Of course the searcher can find much of value in the leading technical papers. But comparatively few water-works superintendents are trained in searching out information from scattered sources, even when files of the various proceedings and journals are available to them. Moreover, such

*Mr. Wisner Martin, Bureau of Highways, Manhattan, 21 Park Row, New York, is secretary of the society. The library work is directly in charge of a sub-committee headed by Mr. Max L. Blum of the same address.

scattered information is likely to be fragmentary, and in any case to find it takes more time than most water-works officials can give or are willing to give to the purpose.

What is needed, therefore, is a concise but comprehensive book on the various phases of water-works maintenance and operation, from repairing a leaky pipe or tapping a main to operating a filtration plant or pumping engine, and from keeping the time of a street gang to making up an intelligible statement of the yearly operations of the water department. To the man who would produce such a volume more than usual returns from the authorship of technical books might be expected, for its sale should be fairly large and quite constant.

Similar remarks might be made with reference to most other classes of engineering work. In few is there any available matter on handling and operation—often as intricate and difficult as design or construction, sometimes even much more so. Now, the engineer's work does not end at the point where the construction has been completed and an acceptance-test successfully passed; operation is also his proper function, and likewise is the equally important matter of maintenance. It is true that, in the past, plants and works of all kinds have usually been operated under the charge of persons not engineers, and that treatises or other literature on operation would have had barren soil to work in. But the time is fast approaching when operation will be *entirely* delegated to the engineer just as are construction and design to-day. When that point is reached, it will be proper and necessary to extend to this subject the same careful analysis and the same painstaking literary treatment as is now given to that.

CORRESPONDENCE.

Needed: A Field Book on Concrete.

Sir: I wish to obtain a book on concrete, particularly Portland cement concrete, and machine mixing, giving amount of cement required for the various sizes of rock and gravel and for different grades of concrete.

Seattle, Wash., Sept. 25, 1904. Engineer.

(The information asked for is at present best obtained from Baker's "Masonry Construction," of which it forms a small part.

The subject of reinforced concrete is now well covered, both theory and practice. A book on the physical properties of cements, mortars and concretes, based largely on laboratory work with these materials, is reviewed elsewhere in this issue of the Supplement.

There seems to be room, and need, for a book devoted to what may be called field practice in concrete work, that is, the purchase and delivery of the ingredients, their storage, the methods of mixing and of delivering and applying the concrete to the various classes of work in which this material is used. The experienced "concrete engineer" who can write and will take time to put his knowledge into written form, may feel assured of producing a successful book.—Ed.)

"Electrigize" Suggested as a New Electrical Term.

Sir: I have been surprised to notice writers and publishers using the word "electrify" and its derivatives to convey certain ideas when there is a much better word available to express the same meaning; in fact, a perfectly concise word, meaning "to operate, work, energize with or by electricity." The common meaning of "electrify" is "to thrill"; the technical meaning "to charge with electricity." What is wanted is a word meaning to work, operate or energize by electricity. We have such a word or can form one from the Greek words "electros" and "ergo," meaning to work, operate, energize or install. "Electrigize" makes a very strong, precise and concise word, and I wonder that the electrical literati are not using it more generally. Respectfully,

Robt. W. Mason.

692 Eighth Ave., New York City, Sept. 17, 1904.

(The question implied in the last sentence finds an answer in the fact that the dictionaries do not contain a word "electrigize." Without going to the point of coining a word, as our correspondent does, an existing word may be drawn into service for the purpose in question: "electrize," which is defined by the Century Dictionary thus:

Electrize.—To make electric; electrify.

This meaning would appear to fit precisely the case of making a railway or an industrial plant electric as to motive power. Electrize may not please every ear, but it certainly is less harsh, is shorter and easier to write and to speak than electrigize.—Ed.)

The Engineer and Mathematics.

Sir: Your editorial of August 18 on the matter of logarithms reminds us of the failure of some of us to keep up in technical things. It is not unusual for veterans as well as novitiates to dodge the use of logarithms because of their seeming cumbersomeness. I have seen a "text-book" that flung logarithms aside as needless, and I have had assistant engineers with diplomas who handled logarithms as awkwardly as they handled a level. To such "engineers" all logarithms seem *unnatural*, and merely part of the black-letter lore of the profession.

It is interesting and possibly inspiring to look back over the work of those who gave us these wonderful implements for the handling of numbers and to listen to Briggs, of Gresham College, saying of Lord Napier's work: "I never saw a book that pleased me better and made me more to wonder." It is well worth one's while to open those four great volumes entombed in Latin, all written in the 17th century, and to see the evidences of patient and scholarly labor on the part of those who discovered and almost completely explored the transcendental region of the "chiliades." Then, if we are curious as to such things, we can go further on into this strange region and meet with the wonders of imaginary functions expressed in real terms—those hyperbolic creatures that link themselves intimately to the equilateral hyperbola and its dainty equation. Sometimes the traveler in this region can almost fancy himself horsed upon some courier of interstellar space, dashing at unimaginable speed along imaginary paths. Of course to the plodding engineer, like the most of us, such excursions are rare delights. In general he must keep to beaten paths, his safe guide and sole monitor some field-book and its rules of thumb, his goal the hastening to the end of the "job" in hand, his ever-present thought the chance of getting another "job."

Blessed is the engineer who can and does have and use books!

James P. Nelson.

Richmond, Va., Aug. 26, 1904.

Paints and Varnishes.

Reviewed by Robert Job.*

THE INDUSTRIAL AND ARTISTIC TECHNOLOGY OF PAINT AND VARNISH.—By Alvah Horton Sabin, M. S., M. Am. Soc. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Limited. Cloth; 6 × 9 ins.; pp. 372; tables, half-tone plates and illustrations in the text. $3.

Comparatively little information is available in convenient book form regarding the technology of paints and varnishes. Therefore this valuable contribution to the subject merits a cordial welcome.

After an introductory explanation of the theory of paints and the manner in which oil and varnish films dry, the author traces the early history of protective coatings from the time of Noah to the present day, mentioning among many matters of interest the varnishes which were used by the Egyptians upon mummy cases 2,500 years ago, and which are still in an excellent state of preservation. Varnish originally was not thinned with turpentine but was spread with the fingers, and from the time of Theophilus (about the tenth century) for about 800 years, practically no progress was made in improving the methods of manufacture.

Linseed oil has been known and used probably for thousands of years, and no paint oil has yet been discovered which approaches it in general efficiency for paint purposes, although, as is well known, it is not by any means free from defects.

Oil dries slowly and requires the addition of Japan to produce hardening within a reasonable time, and the usually accepted theory of driers is given in detail, with the statement that the lead and manganese oxides act as carriers of oxygen to the oil, alternately taking up oxygen from the air, imparting it to the oil and thereby causing partial oxidation of the oil, and then reabsorbing a fresh supply from the air and again transferring it to the oil until the latter is hard. This explanation has always seemed obscure to the mind of the reviewer, who has never seen definite proof of its correctness, for it seems to imply that the lead and manganese salts in solution in all parts of the film are in continual motion, even after the oil has become hardened, and are pushing their way to the surface of the oil for a fresh supply of oxygen and then retreating below the surface to deliver their charge. The reviewer has no better theory to offer, but thinks that the problem undoubtedly needs further study.

In Chapter V. the excellent treatise upon linseed oil by Dr. P. C. McIlhiney, which was prepared for the Department of Agriculture, State of New York, in 1899, is given, and details the best known methods for the recognition of linseed oil and the detection of the usual adulterants, and also gives tables of constants for oil which are of great value to the analysist.

A description of the methods of manufacture of varnishes naturally follows the chapters upon linseed oil, and gives much practical information regarding the various steps in the operations, and explains the uses to which varnishes of different compositions are adapted.

Linseed oil is not the only oil which has been used in painting and varnish making, and brief description is given of various others which have been in more or less general use, tung oil, or Chinese wood oil, for example.

The proper drying of oil is at the very basis of successful painting, owing to the slow rate of drying of raw linseed oil, and in the description of Japans and driers a careful and complete account is given of the different preparations made for various kinds of service, including the well-known baking-japan of the Japanese (the driers very extensively used at the present time to cause proper drying of raw linseed oil) and such baking japans as are used for pipe coatings.

The author has found that very little information as to the efficiency of a given drier can be obtained by chemical analysis, for the simple reason that the practical value of the material may be almost completely destroyed by improper methods of preparation, and the experience of the reviewer is that by far the most satisfactory method for valuation of driers is to determine the physical effect produced when the oil and the drier are mixed in fixed proportions, making comparison with the results produced by a standard drier under the same conditions, and so arranging tests that ingredients, like common rosin, known to be injurious, will be detected if present.

It is shown that the different types of japan differ widely, and the statement is made that "they agree only in perpetuating the record of failure of the European varnish maker to successfully imitate the products of the country whose name it bears." This is a rather severe indictment of present varnish makers.

The well-known bad results of the excessive use of driers is also stated clearly. It is shown that a dryer should be regarded as a necessary evil, since it is a material which actually burns up and destroys paint and varnish, and yet is essential in order to make the material dry in time to be of value under general commercial service conditions.

Many painters have a strong affinity for the undue use of dryers, and, as is stated, it becomes necessary at times to stand guard over the men when an important piece of work is in progress, in order to prevent undesirable additions to the paint. Unfortunately, however, bad materials are also added by some manufacturers, and common rosin is of the worst of these materials, and one very extensively used. A very thorough account is given of the bad effects of rosin both in japans and in varnishes. In fact, from place to place throughout the work mention is made of its injurious results under a great variety of conditions of service in paint oils, varnishes, fillers, japans and dryers. Its main claim is its cheapness, but it generally turns out to be an expensive luxury to the unfortunate user.

Some simple tests are given for the detection of rosin in varnish, but the inference may be drawn that it is best to obtain varnish guaranteed to be free from rosin from reputable manufacturers.

*Chemist, Philadelphia and Reading Railroad Co., Reading, Pa.

This, however, to the mind of the reviewer is better in theory than in practice, and it seems far safer and more logical to make careful test of any given material in order to be certain that no mistake has been made in manufacture, for after the varnish has been applied little redress can be obtained.

In the case of linseed oil, purity or adulteration can be gaged with great exactness, by means of definitely known methods of analysis, and in view of the technical importance of varnish it seems strange that an exact system of valuation has not been worked out, for no mention of such a system is made, and almost the sole dependence as to quality is placed upon long time exposure tests, which from their nature are difficult to make and to carry to completion.

The need evidently is for a short and relatively simple mode of test, by means of which one may determine closely whether material of any manufacturer will give definite results under known conditions. Here, again, there is evident need for further investigation.

The numerous varieties of rosins are described, and a good idea as to the properties of each, and the service to which each may be applied. There is also an important chapter on Pyroxalin varnishes, by Mr. E. D. Williams, Superintendent of the Celluloid Zapon Co., of Millburn, N. J.

In the discussion of paints the curious fact is mentioned that the Dutch process of manufacture of white lead has remained practically unchanged for at least 500 years, and perhaps for five times as long. In fact, an almost identical formula was given in the first century B. C.

An account is also given of various well known pigments, with notes regarding their composition and use. In speaking of pigments like ochres containing clay the statement is made that if they are not roasted and thus, like brick dust, made incapable of uniting with water, they obviously are a source of weakness. This, however, is totally at variance with our own long time service results, and also with the generally well known durability of ochers of good quality. In fact one such pigment of which we have definite knowledge after a very extensive use under widely varying conditions was found to have great relative durability, although it had not been calcined, and actually contained over 12% of water in combination with its clay and iron. It was, however, an exceedingly finely divided inert pigment.

A good general description of paint mills is given, with a general history. In a very complete account of Chinese and Japanese lacquers one gets some idea of Eastern practice by finding that in lacquering 33 different operations were required!

Protection of metals against corrosion is dealt with, and the importance of proper preparation of the surface is emphasized. It is also shown that boiled linseed oil is less durable than raw linseed oil to which a proper proportion of dryers has been added. This antagonizes an old theory or prejudice, but it is the experience of large manufacturers of ready mixed paints, and is in line with the general present practice. Preference is given for varnish paints as the most durable but "a straight linseed oil paint may be made at a lower price than a varnish paint and is the best paint that can be had at the price," while the statement that "there is no oil worthy to be compared with linseed oil for paints" effectively disposes of linseed oil substitutes.

An extensive series of exposure tests of a large number of paints and varnishes is given in detail, and the conclusions are of great value since in most cases the composition is shown and it is possible to draw definite conclusions as to the qualities best adapted for a given service. All of these tests were made by long exposure of coated metal under water, and by far the best results were obtained from the enamel paints made with the more elastic varnishes; that is, with varnishes with a rather large proportion of oil. Such paints gave far better results than linseed oil paints and appear to be well worth their necessarily higher cost.

It is interesting to find that the most durable films under the above exposure conditions were those in which the proportions of oil was about forty gallons per 100 lbs. of unmelted rosin, a proportion which is far greater than that found in almost any of the commercial varnishes. Beyond a certain point the addition of rosin to the oil appears to add only to hardness and gloss, and not to durability, but rather detracts from the latter. This series of tests is well worth very careful study.

Extensive tests were also made upon paints for ships' bottoms. It was found that a good grade of varnish with a little shellac and a very little wax gave the best results, and that a powerful poison such as one of the salts of mercury is very efficient preventive of fouling. Probably no other surface offers so little friction as that of a clear, well dried varnish.

A full account is given of the Sabin method of applying the Sabin protective coating to pipes. As is well known, this material is a baked-on japan and has given excellent service results.

Ship and boat painting, carriage painting, and house painting are also dealt with, and much practical information is given regarding each, both as to paints and coatings and methods of application. The statement is made that "furniture varnish" is a term of reproach among the varnish makers. It is made of "North Carolina Zanzibar Gum," otherwise known as "common rosin." Also the methods used in varnishing common chairs is given, showing how the workman revolves the chair under a varnish sprayer, thus varnishing the entire chair excepting the under side of the seat, which is ordinarily not seen, and which if treated would absorb varnish and thus cause needless waste! Evidently in the varnish trade it is figuratively true that "all is not gold that glitters," for the chairs above referred to are supposed to hold their luster only until sold.

The work closes with a summary of useful information regarding varnishes, and with a good index.

A Study of Earth Dams.

Reviewed by Desmond FitzGerald,* Past Pres. Am. Soc. C. E.

EARTH DAMS.—A Study. By Burr Bassell, M. Am. Soc. C. E., New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. VI. + 70; 3 illustrations in the text. $1.

This octavo volume of 66 pages should make a place for itself in the literature of engineering. The author had supervision of the construction of the great Tabeaud earth dam, 123 ft. in height, and he has evidently made a careful study of the principles involved in the building of earth dams.

The first three chapters of the book cover the investigations connected with the preliminary data usually collected by the careful engineer before beginning his designs. It is surpising how many ways there are of building an earth dam and from how many different points of view one may attack the subject. Some of these we miss in this little book, but a second edition will, we hope, be more extended and embrace more practical information to guide the young engineer. After all, books are generally of most value to the professional man who is beginning his practice; his views and methods are not crystallized and his mind is searching for the best information and his judgment is open to conviction.

However much engineers may differ upon the theory of the earth dam, there is one common ground upon which all will agree, and that is the necessity for providing ample waste weir capacity for maximum freshets. While this is well accented in Mr. Bassell's work, we should like to see it reiterated and reiterated with the greatest emphasis. The great majority of failures of earth dams have occurred from a simple disregard of this important provision. There is little risk, therefore, of running the subject into the ground. A set of rules, such as the author has formulated in the latter portion of his study, should be headed by a rule in capital letters, somewhat after this fashion:

PROVIDE AMPLE WASTE-WAY FOR THE GREATEST FRESHETS, AND LEAVE NO LOOPHOLE FOR ERROR ON THIS HEAD.

The more earth dams an engineer has built, the greater will be the respect with which he will attack this part of his design.

In regard to the question of piercing embankments with outlet culverts or pipes, we find on p. 7:

> The writer would go even further and say that the only admissible outlet for a storage reservoir formed by a high earth dam is some form of tunnel through the natural formation at a safe distance from the embankment.

This of course is conservative advice, but is the hydraulic engineer of wide experience prepared to stand upon this ground in view of the many existing cases where water is taken with perfect safety through the embankment? In some cases that we have in mind the precautions against disaster are so ample as to defy careful analysis.

Chapter IV. embraces a full description of the Tabeaud Dam. The settlement of this high embankment, with 90 ft. of water back of it, was but 0.2 ft., which shows excellent oversight. In English practice the methods used in building so high a bank would probably have involved a settlement of about 1.5 ft. Embankments in the dams of the old Boston water-works, 70 ft. in height, have been built with a settlement of about 0.05 ft., but these dams were raised in layers of 4 ins. and thoroughly compacted. A strong bias was always shown towards the liberal use of gravel, especially in the down-stream half of the embankments which need not contain any water above the valley level if the core walls are properly built.

Chapter V. describes "Different Types of Earth Dams." Under this head it is gratifying to see sections of the San Leandro Dam, 125 ft. in height. The reviewer recently visited this dam, but was unable to find any plans.

Following the rules for the construction of earth dams, are statistics in which, however, we miss some familiar American examples. Mr. Bassell's book is well illustrated by 31 figures which add materially to its value.

In conclusion, we heartily welcome this little book, and doubt not it will find many comfortable niches in engineering libraries.

THE METRIC FALLACY.—By Frederick A. Halsey, And, The Metric Failure in the Textile Industry, By Samuel S. Dale. New York: D. Van Nostrand Co. Cloth; 5¾ × 8¾ ins.; pp. 231. $1.

In the first portion of this volume Mr. Halsey defends the English system of Weights and Measures, claiming that the Anglo-Saxon nations alone have ever dealt with this subject in a rational manners. In condemning the metric system, as a revolution and not an evolution, the author says that its friends do not and can not rely upon the merits of the metric system, but have always resorted to compulsion and have to force its adoption. He gives the pro-metric arguments, and then proceeds to demolish them, quoting from the published statements of the advocates of the metric system and answering each by statements from similar sources. Mr. Halsey, in a similar manner, deals with the persistence of old units in German and French textile and mechanical industries, and a like persistence in other countries. In this connection he gives an interesting and lengthy table of non-metric units used in metric countries. It is not denied that scientific men favor the metric system. But this is explained by the fundamentally different character of scientific and industrial measurements. The scientific use of measurement consists in measuring existing things; the industrial use of measurements consists in making things to a required size. The work itself was largely written to combat a bill before the Committee on Coinage, Weights and Measures of the House of Representatives, which proposed that all departments of the U. S. Government should, after Jan. 1, 1904, use only metric weights and measures in everything except the completion of the survey of public lands. The author concludes that the changing of established standards is impossible, and that the English inch must remain as a standard for all time to come.

The second portion of the work is devoted to showing that no country on earth has made the metric system its textile standard, and Mr. Dale explains in detail why the adoption of metric standards is impracticable in this industry. The author points out the fact that in France itself

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the French weaver still uses the old French inch and other ancient units in his work, and by comparing these old units with their metrical equivalents he makes it plain why one can not be substituted for the other without utter confusion. This portion of the book is decidedly technical, and will doubtless be of more interest to those engaged in the textile industries than to the ordinary reader.

An Important Treatise on the Design of Electric Motors,

Reviewed by Bernhard A. Behrend,* M. Am. Inst. E.

ELECTRIC MOTORS.—Continuous Current Motors and Induction Motors, their Theory and Construction. By Henry M. Hobart, M. Inst. E. E., M. Am. Inst. E. E. London and New York: Whittaker & Co. Cloth; 6 × 9 ins.; pp. 458; 480 illustrations, mostly figures in the text. $5.

The works of Mr. Hobart have always interested electrical engineers. The excellent work that he has done in the past, in conjunction with Mr. Parshall, in the designing of electric generators of the direct-current type and the thorough treatise from the pen of these authors on this subject have merited Mr. Hobart the reputation of one of the foremost electric designers and authors. The present treatise may well be considered a complement to the treatise on electric generators.

The author divides his subject into two parts: continuous-current motors and alternating-current motors, and he devotes eleven chapters to the former and five chapters to the latter.

The design of direct-current motors depends mainly upon a clear understanding of the factors which determine the sparking and upon the limitations imposed by thermal conditions. The three chapters on direct-current motors deal chiefly with data for motor designing, with types of winding, with motor characteristics, and with testing and standardizing of motors. The eleventh and closing chapter deals with variable-speed direct-current motors.

In paragraph 21 of the third chapter, the determination of the reactance voltage is given according to the method which was originally suggested by Messrs. Parshall and Hobart. In this chapter it would have been well if the author had followed the very simple and beautiful method of determining the current under the brush during commutation as it was given by Mr. Alexander Rothert. Mr. Rothert's graphical theory is so simple and explains so well the causes of arcing and of glowing that it should not be omitted in any treatise dealing with direct-current machines.

In Chapter VI. we agree with the author that bar windings are greatly preferable to coil windings, but we disagree with him in regard to his advocacy of such complex grouping of coils as is shown in paragraph 7 of that chapter.

The veritable-speed direct-current motor is at present attracting the greatest attention, and on this account it is to be regretted that Mr. Hobart has devoted little or no space to the variable-speed shunt motors. It is to-day possible, with the modern improved motor design, to obtain a speed variation of from one to four, or even one to six on a single voltage by means of shunt control; in a treatise which claims to be up-to-date, such methods as enable us to obtain these results should have been discussed. This is a serious sin of omission.

Turning now to the second part of Mr. Hobart's treatise, dealing with alternating-current motors it should be stated that the author deals only with the induction motor, and in this field again exclusively with the polyphase motor. Beginning with the description of polyphase induction motors, and their starting devices, of which numerous forms are explained and illustrated by line drawings and pictures, Mr. Hobart enlarges on the sphere of usefulness of the induction motor. It seems to us that here the author loses sight of the most characteristic difference between the direct-current motors and the induction motors, i. e., the fact that the induction motor is essentially a constant speed motor, whereas the direct-current motor is essentially a variable speed motor. In dropping the property of variable speed of the direct-current motor, we lose sight of and sacrifice the prime advantage of the direct-current motor over the induction motor, and it is on this account that we have criticised Mr. Hobart for not devoting more space to the variable speed, shunt wound, direct-current motor. We would also criticise Mr. Hobart for the space given to Zani's method of introducing induction coils to limit the starting current and Mr. Fischer-Hinnen's method of using resistance and inductance in the secondary, since inductance in the secondary of induction motors seriously decreases the power factor and the torque per ampere of the motor.

The calculation of the induction motor is carried on with the aid of the circle diagram. Mr. Hobart says about this treatment:

> This leads us at once to the "circle diagram," due to the investigations of Bedell, Behrend, Blondel, Heyland, Rothert, Steinmetz, and others. A good many questions having been raised as to the priority in this matter, the list has been arranged alphabetically.
>
> The analysis by means of the "circle diagram" is far more expeditious, and the significance of the results is more apparent.

We heartily agree with these remarks of Mr. Hobart's, and we wish to compliment Mr. Hobart on the tactful manner in which he has solved the delicate question of priority.

A great deal of space is devoted in Chapters XV. and XVI. to the leakage factor, or the "dispersion coefficient," as Mr. Hobart calls it. Mr. Hobart follows in this chapter the method which was first suggested by the reviewer and which has now been generally accepted, but Mr. Hobart elaborates Behrend's theory considerably. On this point we wish to quote Mr. Hobart:

> Ih has seemed to the writer that the chief fault in Behrend's otherwise very excellent treatise consists in his overlooking altogether the influence of the inductance of the end connections, which may readily be of preponderating amount, and is in all cases of very appreciable influence upon the total inductance.

The corrections which Mr. Hobart has accordingly made on the writer's formulas are very important and instructive.

The various methods more recently proposed for changing the number of poles in induction motors to obtain variable speed have not been considered by the author, neither has the author devoted any space to the subject of concatenation of induction motors for the purpose of reduction of speed. These subjects treated by so competent an author would have been of engrossing interest to the engineering public.

Some very excellent drawings showing the mechanical details of induction motors are given, and will undoubtedly prove of great interest to engineers and users of induction motors.

The last chapter gives a bibliography of papers on alternating-current *commutating* motors, but, alas, the author is satisfied with giving a list of papers without treating the subject himself.

An alphabetical index is appended to the book, which, however, is rather incomplete.

A writer of Mr. Hobart's high standing in the electrical profession will always be listened to with respect on whatever subject he may desire to speak, and in spite of the omissions in Mr. Hobart's book, the book is most readable and useful, and indispensable to electrical engineers who are working along the same lines. We can speak only with the highest praise of Mr. Hobart's indefatigable industry in writing and compiling a book of such scope, and in liberally giving out valuable data of his designs and the designs of other engineers. The book is to be regarded as an important treatise on the subject of electrical machines.

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Test Data of Cements, Mortars and Concretes.

CEMENTS, MORTARS AND CONCRETES.—Their Physical Properties. By Myron S. Falk, Ph. D., Instructor in Civil Engineering in Columbia University. New York: M. C. Clark. Cloth; 6 × 9 ins.; pp. 176; tables, plates and figures in the text. $2.50.

The purpose of this little book is to present in compact form and in one place the best of the numerous scattered results of tests and studies of the physical properties of cements, mortars and concretes. It is a compilation pure and simple, but a compilation which has been made with a critical knowledge of what is best in the field gleaned by the author. In some instances perhaps, the author approaches his subject from the viewpoint of the physical investigator rather than from the viewpoint of the practicing engineer, but this is quite natural and can not be altogether condemned. Taking the book as a whole it is by all odds the best compilation of test data of the properties of cement and cement products of which we have knowledge. It is deserving of note also that the author gives in all cases references to the sources of his information, which will enable the reader to consult the original results should he in any instance desire to do this.

Turning now to the specific contents of the book, we find first an introductory chapter on the chemical properties of cements. The theories of Le Chatilier and Newberry of the constitution of Portland cement are briefly summarized here, and in an appendix there is a very brief summary of the later theory of Mr. Clifford Richardson. The composition of cements is illustrated by tables of representative analyses of Portland and American natural cements. Slag cements are not considered, and no specific reference is made to the characteristic difference of the so-called magnesian natural cements of America and the non-magnesia natural cements of Europe and a few sections of America. These data are less important than the analyses that are given, but they might have been added with advantage to the book.

The author begins his consideration of the physical properties of cement in Chapter II. Here the author considers tests for specific gravity, fineness, activity, tensile strength and soundness or constancy of volume, and gives quantitative results of representative tests and discusses the various factors that tend to influence or vitiate these results, such as the addition of plaster of paris, temperature of mixing water, variations of sand, and presence of clay in sand. Results are also given of tests made on mortars composed of stone screenings or crusher dust in place of sand. In Chapter III. the author gives results of investigations relating to change in volume of cement mixtures when setting; coefficient of expansion due to temperature changes; action of sea water; porosity or permeability of cement mixtures; effect of freezing; adhesion of iron rods to cement mixtures, and fatigue of cement mixtures.

In Chapters V. and VI. the author considers the coefficient of elasticity and ultimate strength in tension and compression, respectively, of various cement mixtures, that is, various compositions of mortars and concretes. The large number of tables and diagrams in these chapters precludes their consideration here in detail, but the author sums up the balance of evidence in a series of conclusions that are of extreme interest, and makes the following notable statement:

> It is believed that the results obtained relating to the elastic properties of the material, such as the values of the coefficients of elasticity and the ultimate strengths, have been so analyzed that these values may be determined in advance, for any mixture, within small limits of error.

There will doubtless be two opinions of the justice of this confident statement, but if it be true these chapters alone are worth the price of the book many times over to the designing engineer.

The concluding chapter presents numerous results of flexure tests of concrete and reinforced concrete beams, and discusses the theory of flexure as applied to concrete. In this connection the following statement of opinion by the author as to the elastic behavior of reinforced concrete is interesting:

> In the opinion of the author, the elastic behavior of the combination may be deduced by analysis, with the experimental values found separately for the two elements. It is his opinion that the combination of the two materials acts in practice as rational theory might require, although some published experiments ascribe to concrete when reinforced different elastic properties than when not reinforced.

The book closes with a reprint of the report of the American Society of Civil Engineers' committee on Methods of Testing Cement.

The Theory and Practice of Reinforced Concrete.

Reviewed by Prof. A. N. Talbot,* M. Am. Soc. C. E.

REINFORCED CONCRETE.—Part I., Methods of Calculation. By A. W. Buel. Part II., Representative Structures. Part III., Methods of Construction. By C. S. Hill. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 434; tables and 311 figures, some on folding plates. $5.

Engineers who are interested in reinforced concrete and the many others who desire to know more of this new type of construction will welcome the appearance of this volume as a timely contribution to technical literature. It will prove valuable and suggestive to the designer and the constructor. The book is divided into three parts: I., Methods of Calculation, 127 pages; II., Representative Examples, 155 pages; and III., Methods of Construction, 106 pages. The names of these parts are fairly descriptive. Part I. states and discusses formulas and methods of calculations for beams, columns, arches, retaining walls, conduits, etc. Part II. describes and illustrates forms and types of structures which have been erected and gives examples of American practice in design. Part III. describes the various forms of reinforcement and the methods of construction used in foundation work, building work, bridge work, and conduit work, together with something concerning the fabrication of the concrete itself.

The general reader will find Part II. the most valuable portion of the book. Here are gathered descriptions of perhaps two hundred reinforced concrete structures: foundations, piles, floors, beams, columns, walls, roofs, arches, culverts, tunnels conduits, tanks, reservoirs, dams, chimneys—structures from the size of a manhole to arches of 139-ft. span. About two hundred figures are given in Part II., many of them full-page drawings, and these form a valuable collection. They give many practical details, with dimensions, sections, and other information. In fact, Part II. is full of suggestion to the designer, and will prove helpful and stimulating. The descriptions are not critically discussed; they are generally made from the designer's view point and aim to carry an idea of existing conditions. Part III. also contains much matter of practical value: arch centers, forms, false work, methods used during construction, special provisions and precautions. The illustrations here, too, are very good, and the practical suggestions throughout are helpful.

What may be termed the theoretical side of reinforced concrete is not so adequately or satisfactorily treated. It is to be expected that the book will not go far into the field of masonry, but the reader feels that a statement of the properties of concrete and of the principles affecting its proper fabrication and of the laws controlling its action when combined with steel would serve to freshen the memory and help to clear up calculations and design. What is given on concrete is somewhat scattered and not entirely consistent, seemingly being given from various standpoints, and there is little discussion of the properties needed for reinforced concrete. For example, the modulus of elasticity of concrete is given in different places from 750,000 to 7,111,000 (the latter possibly a typographic error) and no statement of the conditions which determine the variation is made. So important a matter as the quality and hardness of steel for reinforcement is hardly touched upon, the only definite recommendation being given in the closing paragraph of an article on one of the formulas for strength of beams. In references to the results of tests and in recommendations for designing, the statements made concerning amount of reinforcement and elastic limit and other qualities of steel are incomplete and may even be confusing to the uninformed reader. The authors do not point out that the formulas given for strength of beams are not applicable beyond the elastic limit of the steel, and judging from the way the factors of safety are used, they can not have realized how far the maximum load must be below what the use of the ultimate strength of the steel in the formula would make it, and they quote with approval a table showing that one of these formulas thus used gives within 0.01% of the average breaking load of 30 beams made under very diverse conditions. The mechanics of their analysis is sometimes mixed, as when on page 23 they in fact equate the moment of the tensile stresses about the neutral axis to the moment of the compressive stresses, and thus in the example cited reduce their resisting moment one half. In discussing the theories of flexure, the distribution of deformations throughout a vertical section seems to have been confused with stress distribution; it is the latter which gives a curved diagram. Perhaps the presentation of several leading formulas for strength of beams is, in the present chaotic condition of the theory of reinforcement, the best way out of the difficulty, and the formulas quoted in the chapter on beams are conservative if consistently used and with proper constants. The treatment of shear in beams is not very instructive. Calculations for arches are more satisfactory and several methods are stated and illustrated, though naturally prominence is given to the method used by a leading designer of long span arch bridges. Much valuable information is also given on retaining walls, dams, etc.

The general make-up of the book is to be commended. The index is good. One wonders why the names of the authors are not given with the title on the back of the volume. Although the authors draw largely from engineering journals and proceedings of technical societies, general credit for which is given in the preface, yet only three specific references to such sources of information were found, and the reader who wishes further details or who desires corroboration of statements of opinions or conditions feels that the omission is a great loss. However, the book will prove to be of real service, and the engineer in general practice, as well as the designer and worker in reinforced concrete, will find it an acquisition to his library and a valuable aid in the study of this new type of construction.

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Historic American Canals.

THE GREAT AMERICAN CANALS.—Vol. I. The Chesapeake & Ohio Canal and the Pennsylvania Canal. Being Vol. 13 of Historic Highways of America. By Arthur Butler Hulbert. Cleveland, O.: The Arthur H. Clark Co. Cloth; 6 × 8 ins.; pp. 231; seven folding and other plates. Complete in 16 volumes. In sets only. $30, net.

By combining in one small volume the history of the Potomac Company, designed to improve the Potomac River, of the Chesapeake & Ohio Canal Co., the Pennsylvania Canal, and the inception of the Baltimore & Ohio and the Pennsylvania Railroads, the author has produced an interesting picture of the early struggles to secure improved means of communication across the Allegheny Mountains. The combined method of treatment also illustrates the futility of certain forms of river development as compared with canals, and, at least for mountainous country, the hopelessness of through water routes as compared with railways.

In his introduction the author shows how natural it was, in the early history of the country, to build great hopes on the canalization of the upper portions of rivers which were navigable below. Benjamin Franklin, partly through information gained abroad, quickly grasped the difficulties involved in treating as canals the upper and at times torrential portions of riv . Washington, who was the first president of e Potomac Co., lacking the benefit of wider obs . vation, and lacking also the intuitive genius and the practical wisdom of Franklin, led the way in the earliest attempts at improving the Potomac—attempts which resulted in ultimate failure. Writing from London in 1772, Franklin advised Mayor Rhoads, of Philadelphia, that canal enterprises in America would be best helped on by first bringing from England a young engineer of some experience in canal construction. He wrote:

> I think it would be saving Money to engage by a handsome Salary an Engineer from here who has been accustomed to such Business. The many Canals on foot here under different great Masters, are daily raising a number of Pupils in the Art, some of whom may want Employment hereafter, and a single Mistake thro' Inexperience in such important Works, may cost much more than the Expense of Salary to an ingenious young Man already well acquainted with both Principles and Practice. This the Irish have learnt at a dear rate in the first Attempt of their great Canal, and now are endeavoring to get Smeaton to come and rectify their Errors.

As Mr. Hulburt points out elsewhere in this volume, the promoters of early internal improvements in America seemed to fail utterly to profit by each other's mistakes.

A companion volume will deal with the Erie Canal, and if equal to this one in interest and suggestions the two may well tempt many an engineer to add somewhat to his library, particularly as good books dealing with the history of early American engineering works are few and far between.

THEORETICAL AND PRACTICAL GRAPHICS.—An Educational Course on the Theory and Practical Applications of Descriptive Geometry and Mechanical Drawing. Prepared for Students in General Science, Engineering or Architecture. By Frederick Newton Willson, C. E., A. M., M. Am. Soc. M. E., Assoc. M. Am. Soc. C. E., Professor of Descriptive Geometry, Stereotomy and Technical Drawing in the John C. Green School of Science, Princeton University. New York: D. Van Nostrand Co. Cloth; 10 × 12 ins.; pp. 287; 478 illustrations, mostly in the text, 65 alphabets and 35 border designs. $4 net.

It appears from the preface that the present is the fourth edition of this work, and that there have only been minor changes from the last edition. The book covers the whole range of its subject from the ruling of straight lines to the generation of a prolate epi-trochoid. The contents include: Fundamental principles of graphic science, free-hand sketching, lettering, choice and use of instruments, kinds and signification of lines, irregular curves, brush tinting, free-hand lettering, titles and borders, blue-printing and other reproductive processes, including lithography, photo-engraving and heliotyping, orthographic projection, Monge's descriptive geometry, solution of spherical triangles, map projection, shades and shadows, perspective, projection, working drawings. The subjects are treated in the order named, which indicates (as is intimated in the preface) that the work was compiled with a view to including in a single volume a complete course in graphics and so grouping the subjects that either elementary or advanced courses could be readily selected.

THERMODYNAMISCHE RECHENTAFEL FUR DAMPFTURBINEN. (A Diagram for Thermodynamic Calculations in Steam-Turbine Design.) Von Dr.-Ing. Reinhold Proell, Dresden. Berlin: Julius Springer. Paper; 6 × 9 ins.; pp. 15; large plate; loose. 2½ marks or $1.

The diagram consists of a series of about a dozen scales, grouped on a single sheet in such arrangement that corresponding points of different scales lie in a straight line. To use the diagram, a straight-edge is laid across it, passing through two points representing known conditions of the steam. A third point, representing another property of the steam under these conditions, is then read off at the intersection of the straight-edge with one of the other scales, suitably selected. The properties involved in the diagram are: pressure, critical pressure, temperature, specific volume, percentage of moisture, total heat, entropy, velocity of flow, and required nozzle section. An instruction pamphlet accompanies the diagram.

EARTHWORK TABLE.—Giving Cubic Yards in 100-Feet Length; for Use in Railway, Street or Canal Work. Prepared by Edgar W. Block, Civil Engineer. Edwardsville, Ill.: The Author. Paper; 4 × 7 ins.; pp. 4. 25 cts.

This pamphlet is of a size suitable for pasting in a field or note book. It is ingeniously worked out so that, given the sum of the end areas in any 100-ft. section, one can read off by inspection the cubic yards contained, to the nearest tenth. The range of the table is up to 1,200 cu. yds.

AMERICAN INSTITUTE OF ARCHITECTS.—Proceedings of the Annual Convention, 1903. Glenn Brown, Editor. Washington, D. C.: The Institute. Paper; pp 229; plates.

Among the papers included in this volume is one on the group plan of public buildings for Cleveland, as worked out by a committee of prominent architects, and one on requirements for modern schoolhouses. The committee reports include contract and lien laws, electrical and fire rules, and the metric system.

A British Book on Steel-Making.

Reviewed by Leonard Waldo,* S. D.

THE METALLURGY OF STEEL.—By F. W. Harbord, Assoc. R. S. M., F. I. C., Consulting Metallurgist and Analytical Chemist to the Indian Government, Royal Engineering College, Cooper's Hill. With a section on The Mechanical Treatment of Steel, by J. W. Hall, A. M. Inst. C. E. The Metallurgical Series, edited by Professor Sir W. Roberts-Austen, K. C. B., F. R. S. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. Cloth; pp. 759; 37 plates, comprising 178 figures; over 280 illustrations in the text, and nearly 100 micro-photographs of steel sections. $9.

This admirable book is a virtual summary of the splendid literature which finds expression in the Journal of the Iron and Steel Institute, and the text-books of Percy, Osborne, Turner, Fairbairn, Jeans and Sir Lowthian Bell. The volume is part of the series devoted to modern metallurgy, for which metallurgical engineers are indebted to the supervising mind of the lamented Roberts-Austen.

The author begins by differentiating steel from iron; ignoring definitions of steel which make capacity for magnetization the criterion, he gives the following definition:

> Steel, using the term as applied to the metal produced by the Bessemer and open-hearth processes, may be defined as purified pig-iron, which, unlike wrought-iron, has been cast whilst in a molten state, and in which the carbon and impurities present in the original pig-iron have been reduced (1) by oxidation alone, (2) by dilution with a previously purified metal, or (3) by oxidation and dilution combined, to such a point that the ingot cast is capable of being forged or rolled into blooms, slabs, etc.

This definition in 1904 might be compared with Percy's definition of forty years before. Percy says ("Iron and Steel," p. 102):

> When (carbon is) present in certain proportions, the limits of which cannot be exactly prescribed, we have the various kinds of steel, which are highly elastic, malleable, ductile, forgable, weldable, and capable of receiving very different degrees of hardness by tempering, even so as to cut wrought-iron with facility, and effusible in furnaces.

From all of which it would appear that the latitude of definition has survived and the legal construction of contracts is not rendered less difficult where the term steel is used free of chemical specification.

In discussing the Bessemer process, credit is given to our distinguished American, Alexander L. Holley, and later in the book, the form of tilting furnace, proposed by Mr. S. T. Wellman, receives its share of attention. The whole question of handling material for charging in bulk, and of handling the liquid melt, by the most modern methods of supporting all heavy weights on roller bearings or friction wheels so as to be easily moved to any part of the works at various stages of the different processes described, is discussed in considerable detail. The modern idea of great tonnage and the consequent assemblage of large plants having this dominating idea in view is partially worked out; but probably most American readers will feel that the book describes English rather than American methods of securing quick and large outputs. The descriptions of the different types of converters, of the various forms of gas producers and melting furnaces, are most freely illustrated. At the ends of various chapters there is given a short bibliography of the subjects treated for the latter half of the book, which includes the heat treatment, the mechanical treatment and the physical qualities of finished steel. There are copiously illustrated sections on rolling mill construction and tube-making. The newer subjects of the changes of structure in steel accompanying definite heat treatment and the micro-photographic study of steel receive their due share of attention.

The book is so complete that one is disappointed in not finding among its tables a resumé of the latest data concerning the thermal problems involved in steel making, such as a table of fusing points of modern furnace brick, clays and furnace linings, and a table of the latent heats of fusion of the various materials used in steel making. There has been much done of late years in pyrometry. The results, scattered through the reports of the Reichsanstalt, various technical journals and the transactions of the various societies, are extremely important and should be incorporated and made available in so valuable a book as this one.

Great as has been our progress in our knowledge of steel, since Stoddart and Faraday wrote their papers on the Alloys of Steel, in 1820 and 1822, in which, by the way, there is some very interesting reading concerning nickel steel and incidentally regarding chromium, iridium and osmium steels, we seem to be now on the threshold of discoveries of the greatest importance. With the development of accurate means of measuring temperatures under 1,500° C., and an increase in our knowledge as to the changes which take place in the iron carbides at different temperatures, there is laid the foundation for the new metallurgy of steel. The advent of such powerful deoxidizers as aluminum, and the far reaching effect of highly fusible metals such as tungsten, chromium, titanium and vanadium and the better-known silicon and manganese gives us unexpected and all but revolutionary results in the whole art relating to armor-plate and projectiles, difficult long-span bridge construction and in those new problems affecting the magnetic circuits in the generation, transformation and control of great power circuits in electrical engineering. This book more than touches upon this rapidly changing situation.

It is highly probable that the steel metallurgist of the future will rely on chemical means to prevent the formation of gases in his ingot or casting, and upon the molecular attraction, while in a thoroughly molten condition, to secure the closeness of grain which is now obtained by costly compression machinery. On these large subjects the book before us is not prophetic and we miss the accounts of heat-treatment furnaces and of the efficient types of heat-recording thermo-electric registering instruments such as are made in Germany and used in the best plants in the United States with the greatest satisfaction.

It is remarkable that two such valuable books as the fourth edition of Ledebur's "Handbuch der Eisenhüttenkunde" and the book before us should appear at about the same time. The complete bibliographies given in Ledebur form a most valuable supplement to those in the book before us. Neither of these works considers the infant industry of the electrical production of steel. However small may be the percentage output of steel by electrical smelting at present, we should recognize that in the induction furnace the steel maker has a new and powerful instrument of progress. In the induction furnace alone can steel be made and kept free from fuel influences and be maintained at any desired temperature and be subjected to any desired treatment, either of addition of ingredients or of exclusion of reducing gases.

One wishes the author had been in a position to tell a little more about armor-plate and armor-piercing projectiles, and about the things they do at the great works (for example of Hadfield) in Sheffield, concerning the methods of which the information is incomplete in the papers published in the Journal of the Iron and Steel Institute; but this longing for more is after all engendered by the large amount of information already given and for that information the reviewer and every owner and user of this excellent book has much reason to be grateful to the author.

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IRRIGATION IN NORTHERN ITALY.—Part. I. By Elwood Mead, Chief of Irrigation Investigations. Bulletin 144, Office of Experiment Stations, A. C. True, Director. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 × 9 ins.; pp. 100; 17 plates and 14 figures in the text.

Familiar with the engineering, cultural and legal aspects of irrigation in the United States, and well aware of our shortcomings in the two latter particulars, Mr. Mead has gathered in the valley of the Po the irrigation practice of the present day, as developed through centuries of experience, and has presented such facts as would best help us make good the shortcomings and solve the problems peculiar to America.

Part I., or the present bulletin, gives the results of studies in Piedmont and Lombardy; Part II. will continue the descriptive matter; Part III. will take up the administration of streams and Government aid in building irrigation and drainage works.

In his chapter on "Irrigation in Lombardy," the author first describes three typical canals, then takes up methods employed in measuring and distributing water, the preparation of land for irrigation, modes of applying water to the crops, the cost and duty of water and the use of water from springs. The same general method is followed in the chapter on "Irrigation in Piedmont." In each chapter canals under both public and private ownership are described.

The illustrations include good half-tone views of irrigation works and also reproductions of line drawings. Altogether the bulletin is a notable addition to the increasingly useful series being published under the direction of Mr. Mead. An earlier bulletin, some will remember, gave the results of observations made in Egypt, not long ago, by Mr. Clarence T. Johnston.

The Latest British Book on Sewage Purification.

THE PURIFICATION OF SEWAGE.—Being a Brief Account of the Scientific Principles of Sewage Purification and their Practical Application. By Sidney Barwise, M. D., B. Sc., Medical Officer of Health to the Derbyshire County Council. Second Edition, Revised and Enlarged, with an Appendix on the Analysis of Sewage and Sewage Effluents. New York: D. Van Nostrand Co. London: Crosby, Lockwood & Son. Cloth; 6 × 9 ins.; pp. 220; folding and other plates and figures in the text. $3.50 net.

A good illustration of the differences between American and British conditions affecting sewage treatment is afforded by certain facts relating to the author of this book. Of him it is interesting to learn that as a County Medical Officer of Health it is his "constant duty" to inspect "some hundreds of sewage works in actual operation" and to analyze "the effluent from such works." It is doubtful whether a single county in any State of the Union or in any Province of Canada has as many as a hundred works for the treatment of sewage, and it is certain that in no county are such works, however many or few, under the supervision of a county official with powers and duties like those of Dr. Barwise. In so far as there is central official supervision of sewage works in this country, it is a State and not a county function, but this and the relative number of sewage works in Great Britain and America are not matters for discussion here. What we wished to do was merely to call attention to some of the great differences between sewage treatment and its supervision at home and abroad, and at the same time explain how a health officer comes to write a book on the purification of sewage. Before leaving the subject, it may be added that most of the recent British books on both sewage and water purification have been written by either health officers or chemists.

The first edition of the book before us was favorably noticed in Engineering News of July 27, 1899, and a supplementary volume, entitled "The Bacterial Purification of Sewage," was also commended in the issue of the same journal dated May 8, 1902. The present volume combines the most essential parts of the contents of both the earlier ones and adds many results of more recent theory and practice.

Considering the size of the volume and the scope of its contents, the new edition is quite satisfactory, but the book continues to be chiefly confined to the principles and history of sewage treatment, and to general descriptions of devices for applying sewage to contact beds and to percolating filters. Notwithstanding these limitations, the book is a valuable one, and as the latest British book on sewage treatment, it is all the more worthy of attention.

Meritorious features of the book are its clear exposition of the fact that there is no *best process* of treating sewage, and its warning to municipal authorities not to adopt patented systems on the strength of statements made by financially interested parties. It is certainly refreshing to find so much open-mindedness in these days when most of the British writers on sewage treatment condemn land treatment and chemical precipitation without reserve and when many of them have a pet system of treatment, sometimes their own, which they advocate in season and out of season. This open-mindedness is largely due, it may be assumed, to the fact that the author has under

his supervision many works and a large variety of methods, and therefore has had an opportunity to see that all virtue is in no one system and that local conditions play a large part in determining the choice of a method.

It should not be understood that the author has no preferences. He clearly states that, where liquefaction is found to be desirable, he favors a septic tank, followed by a lateral contact bed of the so-called Adams type. He also expresses himself quite decidely regarding the relative merits of various filtering mediums, giving some good suggestions on this point. In the chapter on oxidation he presents as an ideal combination an intermittent filter, composed of coal, for purposes of nitrification, followed by continuous filtration "through fine sand or river silt to arrest the bacteria."

The foregoing proposed method of obtaining both nitrification and bacterial reduction suggests comments on the British conception of intermittent filtration and also on their misinterpretation of some phases of the Lawrence experiments of the Massachusetts State Board of Health. Intermittent filtration in England usually means little but intensified broad irrigation, on specially selected land, and sometimes without crops. Dr. Barwise even goes so far as to state, and in this he agrees with British practice, that the intermittent filtration area supplementing a sewage farm be changed each year,

so that the same piece of land becomes an intermittent filter once every eight years. During the time it is being used for intermittent filtration it will store up a considerable amount of manure, which will be utilized while the land is being irrigated.

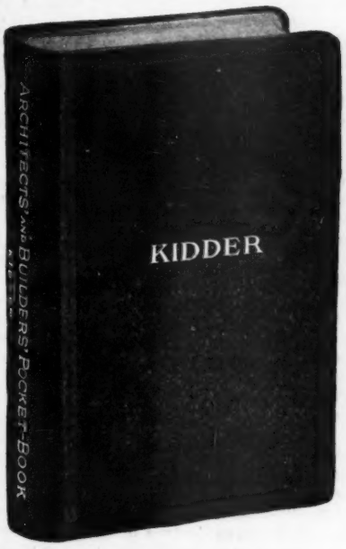
In the same paragraph the author advises an "artificial filter" of coarse material, which, unlike the intermittent filter, will always occupy the same site.

Undoubtedly there is much to be said for such a method of intermittent filtration, both as a relief to a sewage farm and, when connected with such a farm, as a cheap means of providing and maintaining an intermittent filtration area, but nevertheless it is far from the American conception of intermittent filtration. And this leads to a consideration of common British misinterpretation of the Lawrence experiments on the treatment of sewage.

On page 107, Dr. Barwise very courteously credits the Massachusetts State Board of Health with being the first to work out scientifically "the necessity for adequately aerating filters . . . at Lawrence from 1889 to 1893." He then reviews the conclusions based on the early portion (presumably to 1893) of the Lawrence work, and, as usual in British books, belittles it because the experiments were "upon a very small scale" and passes on to the large experimental coke breeze filter of the London County Council.

What we particularly wish to point out is that no British writer seems to be aware that almost from the outset the Lawrence experiments were parallel with the construction and operation of municipal filter plants modelled on the teachings of the experiments. The later annual reports of the Massachusetts State Board of Health describe these municipal intermittent filters and report the results obtained by them, but either British writers generally have not seen the later reports or else ignore them. Almost without exception the British writers treat the earlier Massachusetts experiments as points of origin or departure for British methods of treatment, failing utterly to give Americans credit for having built anything practical upon the Lawrence work.

Not to close without giving a more complete idea of the contents of the book, it may be said that it opens with a discussion of the composition and chemistry of sewage and of river pollution. Land treatment of sewage, chemical precipitation, liquefaction and oxidation are next taken up, after which contact beds and percolating filters are described and compared. A chapter is devoted to automatic devices for applying and controlling the application of sewage to filter beds. The concluding chapter reviews some of the general principles involved in selecting a process of purification. An appendix of two chapters deals with the analysis of sewage and sewage effluents. One of these describes, with the aid of illustrations, the apparatus used, and the other the standard solutions employed. Finally some tables for use by analysts are given.



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CURRENT WHEELS: THEIR USE IN LIFTING WATER FOR IRRIGATION.—Bulletin No. 46, Office of Experiment Station. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 × 9 ins.; pp. 38; illustrated.

Some of our readers may recall a letter published in this journal some months ago in which the possibilities of power development from river currents were discussed. The pamphlet before us describes what has actually been done in obtaining small amounts of power from river currents by irrigators in the West. It appears that practically all the devices in use are really undershot water wheels. Often these wheels carry buckets attached to the rim which fill at the lowest point of their revolution and empty into a trough at the highest point. In a few cases gearing of some sort is used to transmit power to a regular pump.

Most of the wheels are very crude, home-made affairs, constructed of any material that happened to be at hand. They are of all sizes, from little fellows made of old buggy wheels and run in irrigating ditches up to wheels 40 ft. or more in diamater. The land irrigated by these wheels runs from five acres up to 40 acres.

While considerable ingenuity is shown in the design of some of these wheels, particularly in the manner in which they have been patched up out of old materials at trifling cost, it is worth consideration whether some manufacturer of agricultural machinery might not find it profitable to develop the current wheel in a more workmanlike fashion, or at least the parts for its construction, and make it more generally available for the use of irrigators and others. There is undoubtedly a great amount of power going to waste in river currents which may yet be developed and utilized on a much larger scale than is represented by any of the crude machines described in this pamphlet.

The information presented illustrates practice in California, Washington, Idaho, Montana, Utah and Italy, besides which there is a section on the theory of current wheels and a discussion of the wheels described. Each section was prepared by a different author; that on Italy by Mr. Elwood Mead, M. Am. Soc. C. E., Chief of Irrigation Investigations.

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Table of Contents on Application to

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The Elements of Machine Design.

Reviewed by Charles R. Pratt,* M. Am. Soc. M. E.

AN ELEMENTARY TEXT-BOOK ON MACHINE DESIGN.—A Study of Method, with Numerous Illustrations. By Charles Lewis Griffin, S. B. Syracuse, N. Y. The Author. Cloth; 7 × 10 ins.; pp. 181; 82 figures in the text. $2.50.

This book is elementary in the true sense of the word, but machine design is only a compilation of elementary units compiled by elementary thought; and any thought that is not elementary is obscure and misleading.

The author has carefully established a simple base line to build every design upon, and drives home the fact that the smallest detail must be given as careful study and consideration as the most elaborate part of the machine.

There are certainly many draftsmen and engineers who do not think logical mechanics, and if any such are capable of logical thought in machine design, this book will go far to develop it.

The ideal conception of a new machine design is to form the base line in your mind, and then build up the elements in your mental picture before you put a line on paper. This is a natural talent with some, impossible with others, and capable of more or less development by study and application by any who have that best definition of genius, "the capacity for hard work."

Few engineers ever have the ability or the opportunity to excel in more than one branch of the profession, especially in machine design. Nothing but hard lessons of experience will save the engineer from making some fatal error in the critical minute detail, the omission of a lock nut, cotter pin or oil groove, the lack of which may wreck an otherwise perfect machine.

Economic work in machine design is similar to economic machinists' work in respect to data and tools; the machinist can not afford to make all his own tools, and the modern machine designer can not afford to make all of his own calculations from original formulas. There is nothing in shafting, belting or gearing that can not be shown on tables or curves to be read at a glance. One of the best remarks on machine design was made by Professor Sweet of the straight line engine, who said: "While I know of no part of a steam engine that could not be determined by mathematics, I know of no part that ever was so determined."

Notwithstanding the facts stated in the foregoing paragaph, the author begins his discussion of simple questions in belting with logarithms, and thereby limits the utility of his book to college students, barring out the intelligent mechanic and many draftsmen whose opportunities have not led them that far in mathematics.

As indicated by the sub-title, the chief object of the author is to teach *method* of design rather than the detailed solution of specific problems. Part I. is devoted to general method, which is illustrated, as the author proceeds, with the design of a hoisting machine. In Part II. the details or elements of machines are considered.

Some specific points in design, as taken up by the author, may now be criticised:

The author's suggestion to approximate the proportion of machine parts where the design naturally involves a surplus of material and strength is a very practical one, but his method of figuring the strength of the teeth of a cast-iron gear, and then approximating that steel will be strong enough for the pinion, as stated on page 29, is a rather poor one for machine designers; in the particular instance quoted, the steel pinion is of about equal strength to the cast-iron gear, but such approximation of gear teeth might lead to error. The pinion teeth should be figured before the gear teeth.

The author's elementary "analysis" of belts is instructive and interesting, and should have been followed up by more simple mathematics in his "Theory" for the benefit of his elementary readers. However, his closing remarks on belting are very clear and practical, and give more useful information than is found in most text books.

Again in pulleys the author's "analysis" is very clear and elementary, but his "Theory" is an ultra refinement for practical use, and locating the key between spokes, as shown in Fig. 22, instead of in the center of a spoke is an absurd error, but this is corrected by a casual remark on page 94. However, the design of pulleys is now a commercial specialty, and no individual engineer can ever acquire the knowledge of pulley design as well as the parties who manufacture them on a large scale.

It is to be regretted that the author's article on shafting does not contain more elementary matter, as there is nothing in machine design that demands more careful calculation and there is no problem more complex to the student of machine design than the combined strains in shafting. However, the author sticks to his text as he follows the "Method" only of machine design, and leaves further detail data for more complete text books. This also applies to his remarks on gears.

In worm gearing the author fails to lay sufficient stress on the importance of a high angle of the worm thread. Not only does the efficiency vary from 40% at angles of less than 5 degrees, to 90% at angles of from 20 to 45 degrees, but the capacity of transmitting horse power also varies with the efficiency and the design should be made to allow for as high an angle of worm as possible.

Friction clutches are clearly and broadly described, and the same is true of couplings. The application and general design of bolts and keys is also clearly described. The author concludes with interesting remarks on bearings, brackets and stands.

This is strictly a students' book, either for the student at college or for the machinist who studies after shop hours. It is in no sense a reference book or a treatise on machine design, and while it is valuable to a student, it contains no useful data for the machinist, draftsman or engineer to refer to in solving the details of his daily work, but it would be of great interest and benefit to any one interested in machine design to read at his leisure.

As the author says in his preface: "In fact, the whole purpose of this book will be abundantly fulfilled if the student grasps and gets under his control the *method* of Machine Design, and finds himself incited to study the more elaborate works."

*Consulting Engineer, 160 Fifth Ave., New York City.

READY OCTOBER 15th, 1904

A Treatise On Concrete Plain and Reinforced

Materials, Construction and Design of Concrete and Reinforced Concrete, with Chapters by R. Feret, William B Fuller, and Spencer B. Newberry

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CONTENTS.

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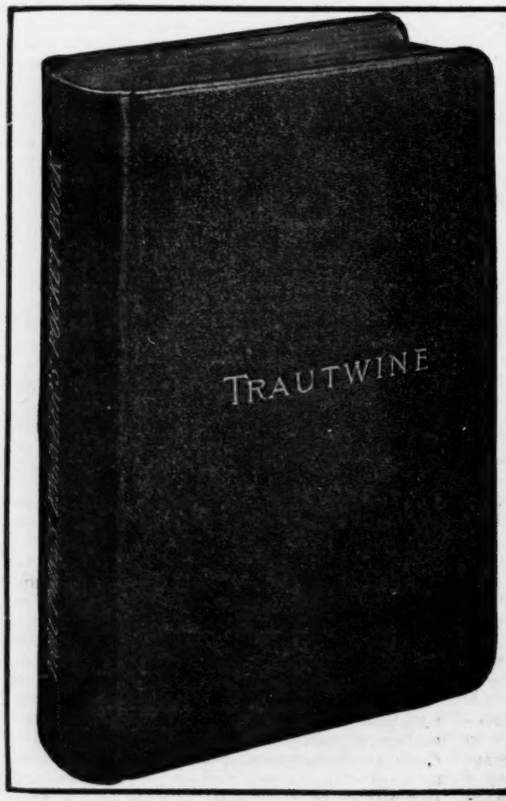

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The Telephone Instrument.

TELEPHONY.—A Manual of the Design, Construction and Operation of Telephone Exchanges. In Six Parts. Part V. The Sub-Station. By Arthur Vaughan Abbott, C. E. New York: McGraw Publishing Co. Cloth; 6 x 8½ ins.; pp. 473; 310 illustrations, mostly in the text. $1.50 per volume, or $8 for the complete work.

In this fifth part of his bulky "manual" of telephony, the author discusses what is no doubt the most generally interesting part of the whole subject. What the author calls the "sub-station," that is to say, the equipment located on the subscriber's premises (in a telephone exchange system), is the theme of this volume; the "sub-station" includes the actual *telephone*, the transmitter and receiver, which remain, in spite of all the marvelous complication of telephone engineering, the most interesting elements of telephony. The better half of the volume deals with these two elements.

Beginning historically, the author describes the original invention of A. G. Bell, which was at first used both as transmitter and as receiver, and which even to-day with but slight modifications is in universal use as telephone receiver. Immediately following Bell's work came the invention of the microphone transmitter, and in consequence the separation of transmitter and receiver. The first chapter of the book deals with telephone receivers and describes various present-day makes of receivers, which differ really in nothing but minor details of construction. In addition it cites the scattered experiments that have been made in the direction of analyzing the electrical elements of receivers, and gives some theoretical considerations that bear (more or less directly) on the performance of the receiver. This part of the book, together with the pages which give similar analytical matter on transmitters, exhibits at once the remarkable scarcity of scientific study in telephony, and the unusual difficulties besetting such study. The questions of articulation, loudness, distortion, quality, etc., are not easily solved by the ammeter and the voltmeter, nor are there available standards by which these questions may be judged.

Transmitters, treated in the next chapter, present a greater amount of development than do receivers. The original Bell instrument was replaced by the microphonic-contact transmitter, associated with the names of Hughes, Edison, Berliner and Blake. The famous Blake single-point contact transmitter finally yielded to the White Solid-Back, a careful development of the granular-carbon contact microphone. This latter forms the basis of all modern transmitters, of which a considerable number is described and illustrated. The illustrations, however, are quite unsatisfactory, as is the case throughout the book. Some matter is then given on the subject of testing transmitters, but here the difficulties already referred to appear in full force.

The remaining half of the book, dealing with Induction Coils and Substation Circuits, Transmission and Current Supply, Signalling Apparatus, Protection, Party Lines, Substation Assemblage, and Costs, is less interesting to the general reader. The first chapter of those noted is, however, of essential importance in considering the telephone proper, for the assemblage of transmitter, receiver and signalling apparatus into a workable telephone is vitally dependent upon the arrangement of circuits employed. Thus, the microphone transmitter reached its full success only by the addition of the local transformer or induction coil, a contribution of Mr. Edison's; again, the talking possibilities of the whole apparatus depend upon the elimination of the accessory apparatus from the main line, accomplished first by the "bridging bell" arrangement and later by the ringer cut-out; and many other secondary problems of great importance to successful service are bound up in the arrangement of electrical circuits at the subscriber's instrument. The chapter dealing with this phase of the subject is hardly less interesting than those dealing with receiver and transmitter, and should be read in connection therewith.

On the whole, this volume is the best of the five yet issued. Unnecessary or extraneous matter, which is often unpleasantly obtrusive in the previous volumes, is practically absent here. There is a consistent and praiseworthy effort to analyze the subject in a scientific manner, which should serve to assist the modern movement toward placing "telephone engineering" on an independent and scientific footing.

Just Published. 4to. 7¾x11. Cloth. 530 pages. 511 illustrations. Price, $7.50 net

REINFORCED CONCRETE

By CHARLES F. MARSH

Assoc. M. Inst. C. E., Assoc. M. Inst. M. E.

WITH MANY TABLES, DIAGRAMS AND ENGRAVINGS

CONTENTS

General View of the Subject. Systems Employed. Materials. Practical Construction. Experimental Research and Data Deduced Therefrom. Calculations. Some Structures which have been Erected in Reinforced Concrete. Appendix.

INTRODUCTION

In the following pages the author has endeavoured to place before engineers, architects, and others, a complete treatment of the subject of reinforced concrete, in so far as is possible at the present day.

All the subject matter has been so arranged as to facilitate reference as much as possible, and the several systems used up to the present have been placed in alphabetical order, so that any particular one may be readily found when desired.

It is believed that the part relating to the calculations, covers all forms of construction in as concise and clear a manner as possible. The formulæ for slabs and beams, although giving somewhat smaller dimensions than those recommended by M. Christophe in *Le Beton Armé* (a standard French work on the subject), are still well on the side of safety, and it is hoped that the tables and diagrams may be of use in saving the labour necessary in making the requisite calculations. The subject of arches has been dealt with in as condensed a form as possible, compatible with a clear demonstration of the methods adopted for locating the pressure curve. The graphical method for finding the stresses to be resisted in domed coverings, is believed to be entirely new and greatly simplifies the treatment of these structures.

It has been considered advisable to illustrate the book very fully, in order that all the subject matter, where possible, may be rendered clearer, and that a true idea may be formed of the remarkable adaptability of reinforced concrete for constructural purposes.

D. VAN NOSTRAND COMPANY, Publishers and Booksellers

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Copies Sent Prepaid on Receipt of Price

PROCEEDINGS OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.—Secretary, L. C. Fritch, 1562 Monadnock Block, Chicago. Paper; 6 x 9 ins.; pp. 834; illustrated.

This bulky volume contains mainly the proceedings of the fifth annual convention, held in Chicago in March, 1904. The reports of 13 committees and the discussions following them occupy about 650 pages, and cover a wide range of subjects. There is also an exceptionally important paper by Mr. J. B. Berry upon the economics of grade and curvature revision, as shown by the extensive work of this kind on the Union Pacific Ry. Lists of officers, members and railways represented, and other miscellaneous matter completes the volume.

THE RAILWAYS IN INDIA.—Administration Report for the year 1903. By C. W. Hodson, M. Inst. C. E., Secretary to the Government of India, Public Works Department (Railways). Simla, India: Pub. Doc. Boards; 8½ x 13 ins.; pp. 354.

The first 25 pages of this annual report contain a general review of the operation of the railways of India, and are followed by about 170 pages of statistical tables, showing the figures for the various individual railways. Two other tables give statistics of the principal bridges and tunnels, and the remainder of the volume is devoted to a summarized history of each of the railways.

A METHOD OF DESTROYING OR PREVENTING THE GROWTH OF ALGAE AND CERTAIN PATHOGENIC BACTERIA IN WATER SUPPLIES.—By George T. Moore, Physiologist and Algologist in Charge of Laboratory of Plant Physiology, and Karl F. Kellerman, Assistant in Physiology. Bulletin No. 64, Bureau of Plant Industry, B. T. Galloway, Director. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 ins.; pp. 44; tables.

The greater part of the contents of this bulletin was reprinted in Engineering News of May 26. The pamphlet was the first and still is the only official announcement of the investigations by Dr. Moore and his assistants of the use of copper sulphate to prevent trouble with algae in reservoirs. The application of the method to a number of reservoirs has been described in several issues of Engineering News during the past few months.

EARTH DAMS

A Study

By Burr Bassell

M. Am. Soc. C. E.

CONTENTS

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The Engineering News Publishing Co.

220 Broadway, New York

Literary Magazines.

Scathing words are used by Miss Tarbell in concluding her second series of Standard Oil articles in "McClure's" for October. The sum of the whole matter, she says, is that the company has ruined others not to save but to aggrandize itself; that the ethical is worse than the economic effect, because it is more far-reaching and because it threatens the very foundations of society; that this particular company is only somewhat worse than numerous others and only worse because more powerful; and finally that the cure for the evil rests with the whole people. Their "first task is to secure, free and equal transportation privileges by rail, pipe and waterway. Their second and ethical task is to arouse and perpetuate 'an increasing scorn of unfair play.'"

Rarely does a month pass without a discussion of the labor problem in one or more of the magazines. This month the "Atlantic" has an article by Charles J. Bullock on "The Closed Shop." The object of the article is to show the "purpose and logical consequences" of the closed shop and to aid in a realization of the "far-reaching consequences" of passing "a sentence of economic outlawry upon non-union men." The "Review of Reviews" also discusses the labor question in "This Year's Strikes and the Present Situation," by Victor S. Yarros. Another article in the last-named journal deals with the recent meeting of the Society of Chemical Industry and still another pictures the Jungfrau Railway.

The editor of "The Cosmopolitan" having returned from St. Louis and had his say about "The Fair" again gives other people a chance. The demand or supposed demand of the general public for articles on industry and science is catered to by a description of the manufacture of "Tin and Terne Plates," besides which there is an article on irrigation and one entitled "Will Marconi Supplant the Cables?" Not to-morrow, is the answer to the last.

New York's underground railroad is well illustrated in the "World's Work," which also contains illustrated articles on "Rebuilding a Great Railroad," by Frank H. Spearman, and on "The Yale Summer School of Forestry," by James W. Pinchot.

The author of the last-named article is the father of Mr. Gifford Pinchot, well-known for his forestry work in the United States. The elder Pinchot states in this article that he advised his son to make forestry his profession. The Yale Summer School, some may like to know, is at Grey Towers, in Northeastern Pennsylvania.

Besides its usual quarterly review of "Applied Science," by Henry Harrison Suplee, "The Forum" contains a special article on "Protection Against Fires and Faulty Construction," by Louis Windmuller. This is little more than a review of divers sorts of great fires, recent and long past, with some of the lessons they teach.

The most promising article in the three English reviews that come to us is one on "The Political and Industrial Situation in Australia," by Tom Mann. Australia generally and Victoria in particular is here reviewed. Among the wide range of subjects touched upon is the sewage farm of the Melbourne and Metropolitan Board of Works which the author states now yields "a solid £6,000 per annum net profit," but not counting the cost of pumping the sewage to the farm, which is met by taxation.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—Proceedings for 1903, together with Constitution, By-Laws, List of Members and Annual Report. Andrew J. Provost, Editor. New York: The Society, 142 W. 40th St., New York City. Paper; 6 × 9 ins.; pp. 140 + 55; folding and other plates.

The opening paper in the initial volume of this new society is on "Park Engineering in the Boroughs of Manhattan and the Bronx," by Mr. Nelson P. Lewis, M. Am. Soc. C. E. The next paper, and the only one not dealing with local problems, is "The Old Roman Aqueducts," by Mr. Edward Wegmann, M. Am. Soc. C. E. "Rapid Transit in New York City," by Mr. Geo. S. Rice, M. Am. Soc. C. E., and "Some Street Traffic Problems," by Mr. Wisner Martin, M. Am. Soc. C. E., follow. Asphalt pavement maintenance is discussed by Dr. James C. Bayles. A general discussion on the recent investigations for a new water supply for New York, the presidential address of Mr. Lewis, notes on visits to the tower foundations of the Manhattan Bridge, to the New Crotion Dam and on the annual dinner, complete the main section of the volume. The constitution is printed as revised on Sept. 28, 1904. The list of members includes 312 names. Typography and illustrations are in accord with the high character of the papers and discussions, and altogether this first volume of Proceedings is a creditable production which promises well for the future of the new organization.

IRRIGATION AND DRAINAGE INVESTIGATIONS.—Conducted by the Office of Experiment Stations, U. S. Department of Agriculture. By R. P. Teele, Editorial Assistant, Office of Experiment Stations. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 × 9 ins.; pp. 23; two plates and five figures in the text.

Intended primarily for distribution at the St. Louis Exposition, this pamphlet very properly contains a brief historical review of the work indicated in the title and describes in outline the main divisions of that work.

Publications Received.

ARCHITECT'S AND BUILDER'S POCKET-BOOK.—A Handbook for Architects, Structural Engineers, Builders and Draftsmen. By Frank E. Kidder, C. E., Ph. D., F. I. A., Consulting Architect and Structural Engineer, Denver, Colo.; Author of "Building Construction and Superintendence." Fourteenth Edition, Rewritten. New York: John Wiley & Sons. London: Chapman & Hall. Leather; pp. xix + 1,656; 1,000 figures in the text.

ROCK EXCAVATION.—Methods and Cost. By Halbert Powers Gillette, M. Am. Soc. C. E., M. Am. Inst. M. E., Late Assistant New York State Engineer. New York: M. C. Clark. Cloth; 5½ × 8 ins.; pp. 376; 56 figures in the text. $3.

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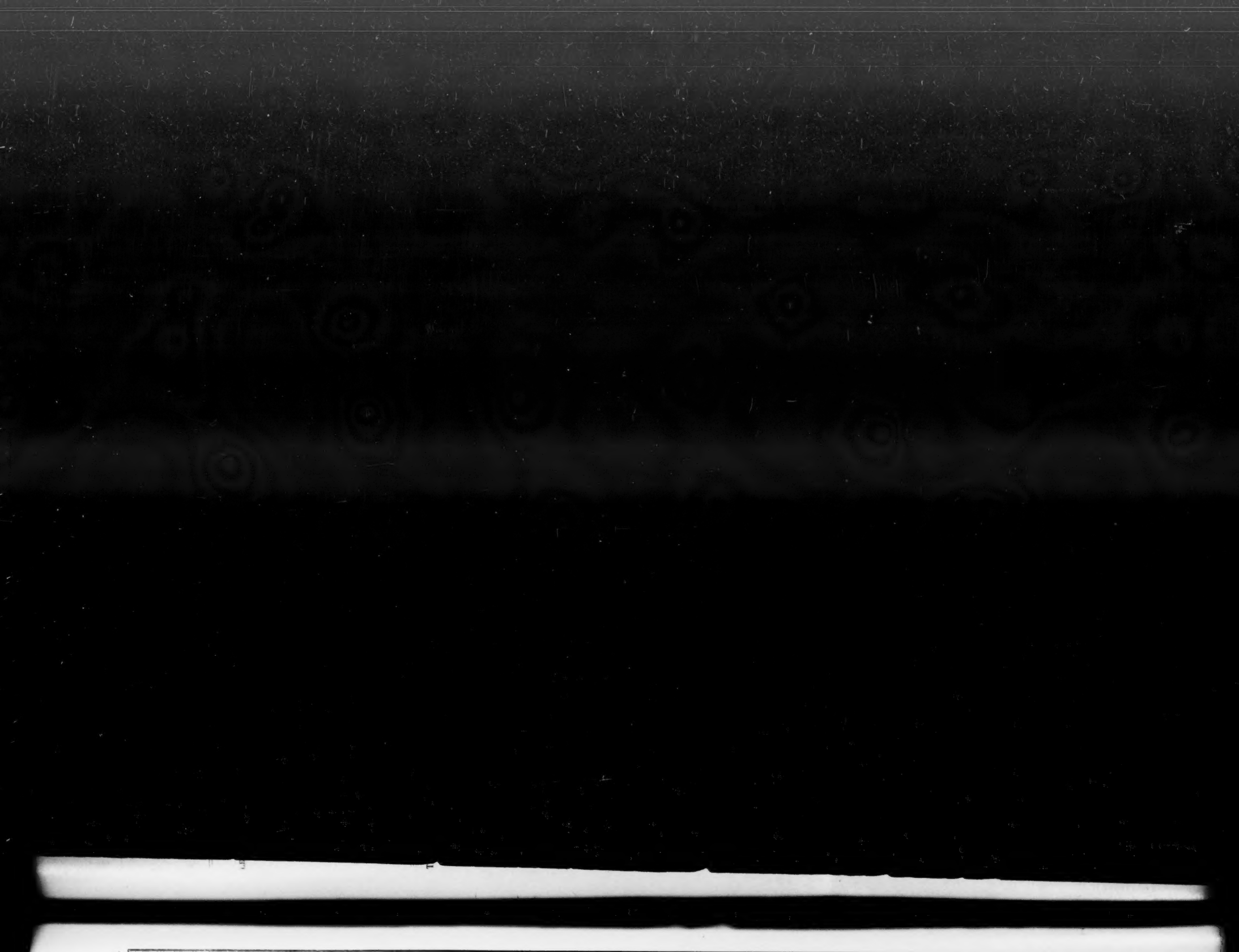
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